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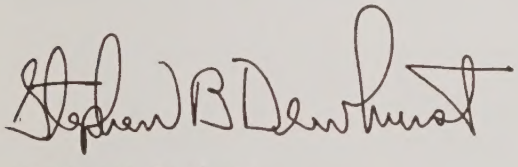
Natural Resources

Federal Spending and Resource Performance 1940-1989

Foreword

The primary role of a staff organization is to assist decision-makers by providing facts and perspective concerning issues. The following paper, developed by John Fedkiw, helps fulfill this role in the area of natural resources. It brings together a large body of information about Federal spending and natural resource performance over the past 50 years. It does so in a way that provides insight concerning this historical performance and a guidepost for considering emerging and future issues. In this context it is a significant addition to the growing body of work now available on the renewable natural resources and the institutions influencing their performance.

I would remind readers that natural resources issues are among the most complex and controversial facing our society. While papers such as this one can help focus the discussion, they cannot and should not become a substitute for the responsibility of decision-makers to reach their individual considered judgments on these matters. In this area, as in many others, difficult challenges lie ahead. There are no easy answers.



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Introduction

This paper reviews Federal spending for natural resources over the 50 years from 1940 through 1989. The purpose is to better understand its relationship to U.S. population and economic growth and to total Federal spending levels. The general performance of the nation's natural resources is also examined to provide an output context for assessing the performance of Federal resource spending itself—a changing mix of programs and functions but a comparatively stable annual total funding, as measured in constant 1982 dollars for traditional resource programs.[1/]

The relatively flat trend in Federal spending for natural resources since 1940, excluding the increase for pollution control and abatement since 1970, raises a question as to how the nation has been able to achieve the general natural resources progress that has been increasingly reported in a variety of publications in recent years.[2/] The interpretations and inferences prompted by the relationship between Federal spending and resource performance provide important hypotheses, inferences, and understandings for both resource and environmental interests. They also offer a stimulus for some researchable questions about the use, management, and performance of our natural resources and the environment they support in the hands of a free, democratic republic and society. Kenneth D. Frederick and Roger A. Sedjo (1991), editors of the Resources for the Future book America's Renewable Resources: Historical Trends and Current Challenges said it this way: "Understanding past trends in the condition and use of the resources and how society has responded to prior resource stress is an important step...to the formulation of good resource policy".[2/]

[1/]Unless otherwise stated, the discussion of spending and expenditure trends in this paper is in terms of constant 1982 dollars.

[2/]See Appendix A for a listing of such publications and includes the Federick and Sedjo, 1991 reference.

The Extent and Role of Federal Natural Resource Programs

Federal spending for natural resources currently exceeds $15 billion a year, covers a broad range of Federal programs and functions, and involves many different agencies. It influences public and private resource use and management in all 50 States through implementation of national goals, policies, and priorities for the nation's natural resources and the environment. That, in turn, influences policies and spending at State and local government levels and among many owners of private lands and their related resources.

Federal spending is documented in this paper for five groups of resource programs and agencies. The groupings are those used by the Office of Management and Budget (OMB) in the Executive Office of the President to summarize natural resources and environment spending within the Federal budget. They account for all spending in the Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers, almost all spending in the Department of the Interior (DOI), large segments in the Department of Agriculture (USDA), small amounts in the Departments of Commerce (DOC), State, and Transportation, and a limited assortment of relatively small independent commissions. The first four groupings are referred to herein as the traditional resource programs. The pollution control and abatement grouping constitutes the bulk of Federal spending for the environment beginning in 1970. The OMB groupings and their major components are:

Water Resources: Bureau of Reclamation in DOI, U.S. Army Corps of Engineers in DOD, and Soil Conservation Service water resource programs in USDA. (OMB Code 301)

Conservation and Land Management: Bureau of Land Management, Bureau of Indian Affairs and Office of Surface Mine Reclamation in DOI and the Forest Service, Soil Conservation Service, and the Agricultural Stabilization and Conservation Service cost sharing and the Conservation Reserve Programs in USDA. (OMB CODE 302)

Recreation Resources: National Park Service and Fish and Wildlife Service in DOI. (OMB Code 303)

Other Natural Resources: Geological Survey and Bureau of Mines in DOI and the National Oceanic and Atmospheric Administration in DOC. (OMB Code 306)

Pollution Control and Abatement: Environmental Protection Agency, including grants for construction and Super Fund for hazardous waste management. (OMB Code 304)

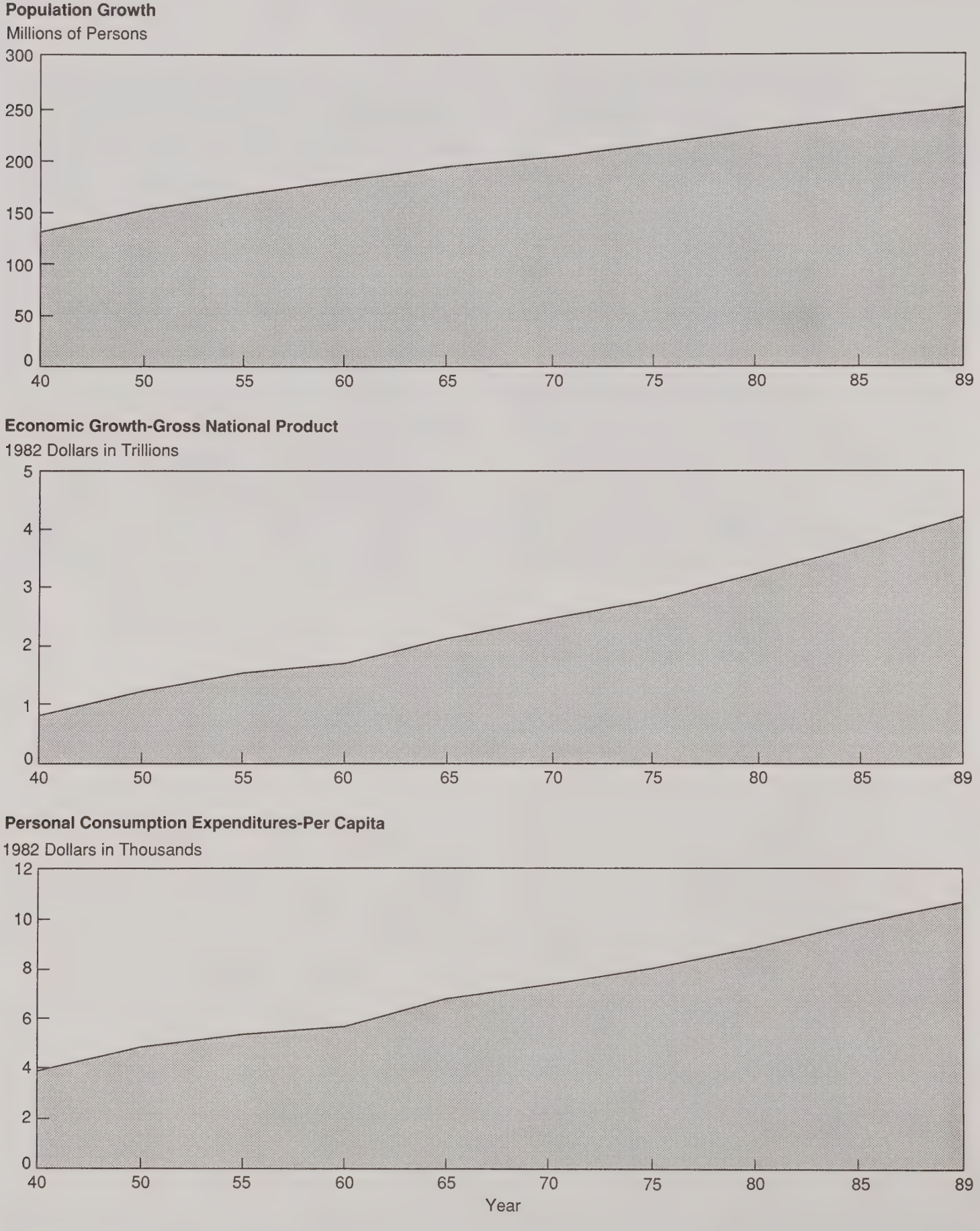
The Influence of U.S. Population and Economic Growth

The U.S. population almost doubled between 1940 and 1989. It rose from 132 million to 250 million (figure 1). In the same period the national economy expanded more than fivefold in terms of real purchasing power. The gross national product, measured in constant 1982 dollars, rose from less than $0.8 trillion to $4.2 trillion (figure 1). Thus, there was a great expansion of consumer purchasing power in terms of both population growth and increased economic welfare. That expansion is expressed in figure 1 by the growth per capita of personal consumption expenditures. They rose by a factor of 2.8 from $3,800 to $10,700 per capita, measured in constant 1982 dollars. However, there were nearly twice as many people in 1989 as there were in 1940. So, total realized consumer demand rose by a factor of 5.3.

This rapid national growth placed unprecedented demands on the nation's natural resources. The number of households rose from 35 million in 1940 to more than 93 million in 1989, along with a substantial need to replace older homes. As a result, new housing construction rose from less than 400 thousand units a year in the 1930's and early 1940's to 1.5 million a year in the postwar period to 1970 and an average of 2.0 million a year from 1970 through 1986. Total wood consumption nearly doubled. It rose from less than 12 billion cubic feet a year to 20 billion cubic feet and continues to rise. Beef consumption per capita more than doubled in this period to its peak level in 1976. To meet this growth in consumption, the cattle herd increased from 77 million in 1940 to 132 million in 1975, increasing forage demands accordingly. After 1975, per capita beef consumption dropped significantly, leading to a reduced cattle herd of less than 100 million in recent years.

Outdoor recreation demands on natural resources soared in every dimension to reach peak levels in the mid-1970's. Recreation use, thereafter, continued to grow but at a much slower rate. Manufacturing, construction, and energy consumption expanded even more rapidly than user demands on natural resources. Emissions, effluents, and wastes from these sources and from urban community growth and development significantly increased the demands on the nation's air, waters, and lands for their dispersal and disposal. Thus, rapid national growth in every dimension brought unprecedented demands not only for the use of the nation's resources for beneficial purposes but also for the disposal of many waste products and residues of that growth.

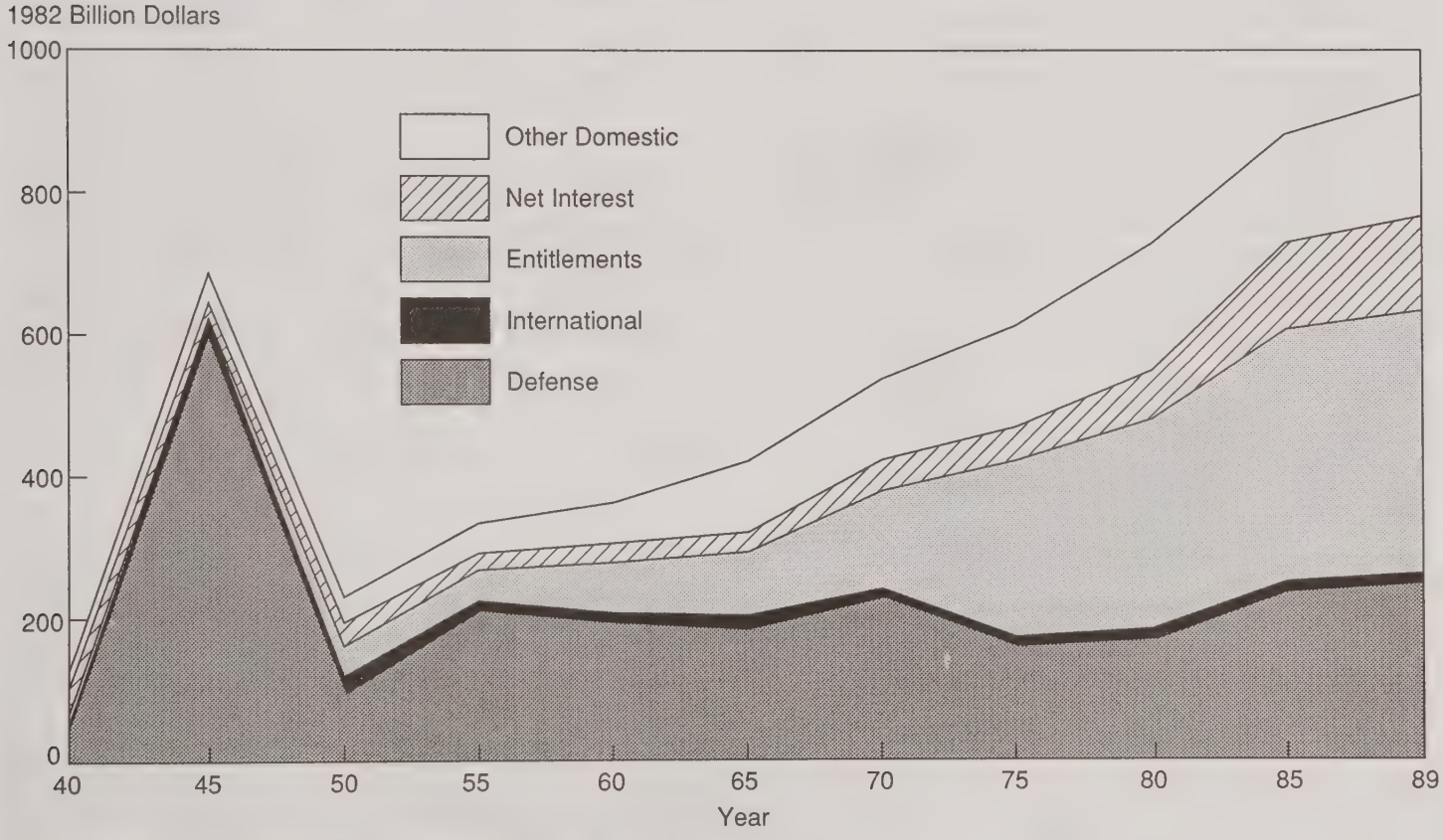
Figure 1. U.S. Population and Economic Growth and Personal Consumption Expenditures Per Capita, 1940-1989



Federal net spending represents the direct burden of Federal programs on taxpayers. Federal net spending is briefly examined here to provide a broad perspective on the trend in total Federal spending and spending by major Government functions. It also provides a perspective on the changing natural resources and environment share of total Federal spending.

The trend in Federal net spending from 1940 to 1989 is shown in figures 2 and 3 for 10 major functional groupings.[3/] The major Government functions and their component subfunctions are outlined below. In figure 2, "Other domestic functions" are shown as an aggregate. Figure 3 shows the separate components of this functional grouping.

Figure 2. Federal Net Spending by Function, 1940-1989



Source: Historical Tables, Budget of the U.S. Government FY 1990, Table 3.1

[3/]The data and methodology for quantifying and graphing net Federal spending trends are described in appendix B.

Federal Budget Functions and Subfunctions

National Defense

International Affairs

Entitlement Programs
- Medicare
- Income Security
- Social Security
- Veteran benefits and services

Net interest

Other Domestic Functions

Administration
- General Government
- Justice

Social Programs
- Education, Training, Employment, and Social Services
- Health

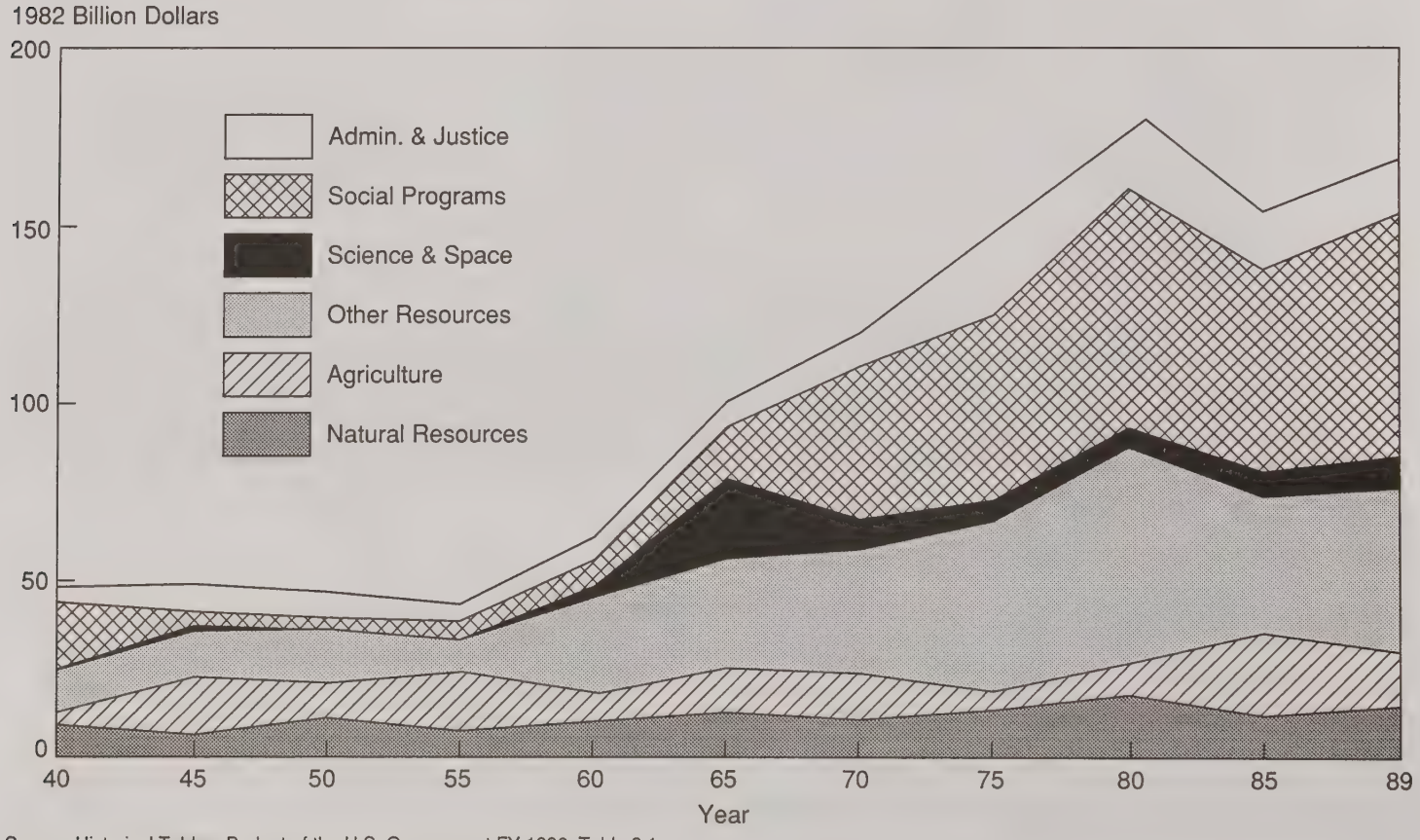
General Science, Space, and Technology

Other Resources
- Energy
- Commerce and Housing Credit
- Transportation
- Community and Regional Development

Agriculture
- Farm Income Stabilization
- Research and Services

Natural Resources and Environment
- Water Resources
- Conservation and Land Management
- Recreation
- Other Natural Resources
- Pollution Control and Abatement

Figure 3. Other Domestic Federal Net Spending by Function, 1940-1989



Source: Historical Tables, Budget of the U.S. Government FY 1990, Table 3.1

Total Federal net spending from 1940 to 1989 rose almost 11-fold, from less than $90 billion to more than $930 billion. That compares with a doubling of population and a five-fold increase in GNP. As a result, Federal net spending rose from 9.9 percent of GNP in 1940 to 22.2 percent in 1989.[4/]

The great majority of the increase in Federal spending occurred in the defense, individual entitlement, and net interest functions, which, together with the international function, rose from $37 billion in 1940 to $763 billion in 1989, more than 20-fold. For the aggregate of other domestic functions, which includes natural resources and the environment, net spending rose 3.4-fold in the same time period. Thus, the share of Federal net spending for other domestic functions decreased from 55 percent to 18 percent. It dropped sharply from its expanded 1940 level to 20 percent in 1950, and then varied between 13 and 25 percent in the following four decades.

Net spending for natural resources and the environment declined after 1940 and remained below the 1940 level of $9.5 billion for three decades (see table 1). It rose after 1970 in response to new national priorities for environmental protection. In 1989, it totalled $13.0 billion, which was 1.4 times above the 1940 level. As a result, the natural resources and environment share of Federal spending in this 50-year period declined from 11.3 percent to 1.4 percent of total Federal net spending, and from 19.8 percent to 7.7 percent of net spending for other domestic functions.

Federal spending for natural resources in 1940 was relatively high. Federal programs for job creation were a major contribution to that spending. The 1940 unemployment rate was high, 14.6 percent.[5/] The Depression-spawned economic relief programs were still operating. They included the Civilian Conservation Corps and various public works programs that focused on soil and water conservation, public forest and park developments, and water resource projects. They made up over 50 percent of natural resource spending. The Agricultural Conservation Program, instituted in 1938 to provide farmers financial assistance to shift farmland out of crop production to conservation uses, added another 10 percent. Natural resources net spending remained relatively close to the 1940 level until after 1970, except for the depressing influence of defense spending for World War II (early 1940's) and the Korean War (early 1950's).

With the advent of new environmental protection priorities in 1970, the natural resources share of total Federal spending rose to 2.2 percent in 1980 then declined to its lowest level in 50 years (except for World War II) , 1.4 percent in 1985 and 1989. Its share of other domestic functions increased to 9.0 percent in 1980, then declined to 7.8 percent in 1985 and 7.7 percent in 1989.

[4/] Office of Management and Budget, Executive Office of the President of the United States, 1989, Historical Tables, Budget of the United States Government, Fiscal Year 1990, Table 6.2, U.S. Government Printing Office, Washington, D.C., pp. 132-141.

[5/] Economic Report of the President, 1990, Table C-32, U.S. Government Printing Office, Washington, D.C., p. 330.

Federal Gross Spending for Natural Resources and Environment by Subfunction

Gross spending for natural resources and the environment represents the total direct Federal investment for resource protection, development, and management. It exceeds net spending because receipts attributable to natural resource programs are not deducted as offsets to gross outlays or expenditures. Table 1 and figure 4 display the trends in gross spending for natural resources and its subfunctions: water resources, conservation and land management, recreation resources, other resources, and pollution control and abatement. Total net spending and offsetting receipts for natural resources and environment are also shown in table 1 for comparative purposes.

Over the 50-year period, gross spending averaged 19.0 percent more than net spending, but declined from 20.6 percent for the 1940-65 period to 17.9 percent for 1970-89. The decline reflects a much greater growth in pollution control and abatement programs relative to the growth in receipts. Offsetting receipts rose from an average of $1.5 million before 1970 to an average of $2.2 million for the 1970-89 period. Pollution control and abatement spending increased several billion dollars after 1970.

Table 2 offers a more consistent basis for comparing gross and net spending by excluding pollution control and abatement for which receipts averaged less than a half of 1 percent of gross spending and 1 percent of total receipts over the last decade. On this basis, gross spending for traditional resource programs averaged 23.6 percent higher than net spending for the 50-year period and rose from 20.9 percent before 1970 to 26.3 percent from 1970 to 1989. Since 1980, 86 percent of the offsetting receipts were generated by the conservation and land management programs, 9 percent by water resource programs, and 4 percent by recreation and other resource programs. The percentage of excess in gross over net spending rises because the relative increase in offsetting receipts, 47 percent, is greater than the 18-percent relative increase in total net spending. However, the absolute increase in net spending for traditional resources programs between the earlier and later years is twice as great as the receipts increase. Thus, Federal allocation of funds for traditional resources does not appear to be generally constrained by receipts even though they may be a consideration in some particular program allocations.

Total gross spending for natural resources and environment increased 1.7-fold between 1940 and 1989, substantially more than the 1.4-fold increase in net spending. This more favorable view of the Federal role in gross spending for natural resources and environment arises from the removal of the budget accounting influence of offsetting receipts. Gross spending for the traditional resource programs, however, remains relatively flat, increasing only 1.2-fold from 1940 to 1989 (table 2). Nevertheless, the relative mix among these programs changed significantly and continuously throughout this period, indicating changing relative priorities (figure 4). Spending for water resources, for example, reached peak levels in 1950 and 1965, and then declined steadily after 1965 in both dollars and share of traditional resource programs.

Spending for conservation and land management after 1940 was sharply reduced—both in absolute amount and as a share of total resource spending. This reflected the termination of the Civilian Conservation Corps and other work relief programs of the Depression period. In the late 1950's and early 1960's, conservation and land management spending expanded again, largely in response to the Soil Bank Program which shifted over 20 million acres of cropland into conservation cover for a 10-year contract period. It declined again with the expiration of the Soil Bank Program, reaching a new low in 1975. It expanded once more in the late 1970's, but was retrenched after 1980 in response to budget constraints as well as to depressed economic demands for resource production. The expansion in 1989 reflects the rising cost of the 1985 Food Security Act provisions for long-term withdrawal of cropland from production and conversion to a conservation cover under the Conservation Reserve Program. The cost of withdrawing land from crop production, however, is offset to some extent by reductions in those Federal farm support programs carried in the agriculture function of the budget.

Spending for recreation-related resources in 1940 was very minor and limited mainly to Federal lands, primarily for the National Park System and the Fish and Wildlife Service programs. As recreation use of national parks increased from 6 million visits in 1942 to 72 million in 1960, spending for recreation, primarily the National Park System, rose modestly. Following the studies and recommendations of the Outdoor Recreation Review Commission in 1962, recreation spending accelerated, reaching a peak level of $1.9 billion in 1980 and declining to $1.5 billion in 1989. The recreation share of traditional Federal resource spending grew throughout this period from 3 percent in 1940 to 14 percent in 1989.

Other resource spending for National Oceanic and Atmospheric Administration programs, the Geological Survey, and minerals management on Federal lands grew slowly but steadily throughout the 50-year period. Other resource spending as a share of total spending for traditional resource programs rose from 2 percent in 1940 to 14 percent in 1989.

Federal pollution control and abatement activities began to be funded in the 1960's through the initiation of various small programs to deal with air pollution, solid wastes, radiation dangers, and contamination of pubic water supplies. They were initially administered by the Departments of Health, Education and Welfare and Interior and grew modestly in the 1960's.

Table 1. Federal Gross Spending for Natural Resources and Environment by Subfunction

Resource Subfunction	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1989e
	1982 dollars in billions										
Water	3.1	2.1	5.8	3.7	4.7	5.9	4.4	4.8	5.0	3.8	3.7
Conservation & Land Management	5.7	3.6	2.2	2.3	3.7	3.6	3.0	2.8	3.8	3.4	4.7
Recreation	.3	.1	.3	.4	.5	.8	1.0	1.4	1.9	1.5	1.5
Other Resources	.2	.4	.4	.5	.7	1.1	1.2	1.3	1.6	1.5	1.5
Pollution Control & Abatement	-	-	-	-	.1	.5	1.0	4.4	6.5	4.0	4.0
Total Gross Spending	9.3	6.2	8.7	6.9	9.7	11.9	10.6	14.7	18.8	14.2	15.4
Total Net Spending	9.5	4.9	8.2	5.0	6.7	9.4	8.6	12.8	16.2	11.9	13.0
Indicated Offsetting Receipts	neg [1/]	1.3	.5	1.9	3.0	2.5	2.0	1.9	2.6	2.3	2.4

[1/] Offsetting receipts were negligible in 1940. The slight excess of net over gross spending is an anomaly between data sources for gross and net spending.

Table 2. Federal Gross Spending for Traditional Resource Programs, 1940-1989

Type of Spending	1940	1945	1950	1955	1960	1965	1970	1975	1980	1985	1989e
	1982 dollars in billions										
Gross	9.3	6.2	8.7	6.9	9.6	11.4	9.6	10.3	12.3	10.2	11.4
Net	9.5	4.9	8.2	5.0	6.6	8.9	7.6	8.4	9.7	7.9	9.0
Offsetting Receipts	neg	1.3	.5	1.9	3.0	2.5	2.0	1.9	2.6	2.3	2.3[1/]

[1/] Reduced from $2.4 billion shown in table 2 for receipts attributable to pollution control and abatement; 1989 is the only year such receipts approached $100 million.

These programs, together with several small environmental protection activities of the Department of Agriculture, the Atomic Energy Commission, and the Federal Radiation Council, were transferred to the Environmental Protection Agency, which was established in December 1970.[6/] Beginning with the billion dollars available in the existing programs of 1970, spending for pollution control and abatement rose rapidly to $6.5 billion in 1980 in response to the National Environmental Policy Act of 1970 and subsequent clean air and clean water amendments.

Environmental spending within the traditional resource programs also increased between 1970 and 1980. This included all the agencies of the Department of the Interior and most of the programs of the National Oceanic and Atmospheric Administration in the Department of Commerce, the Forest Service and Soil Conservation Service in the Department of Agriculture, the Corps of Engineers in the Department of the Army, and a small amount in the Department of Transportation. Gross spending for environmental purposes in these agencies increased from a base level of $3 billion in 1970 to $5 billion in 1980. Spending for environmental purposes was reported annually for all Government agencies in this period for three broad categories:

- Pollution Control and Abatement
- Environmental Protection and Enhancement
- Understanding, Describing, and Predicting the Environment.

[6/] The Budget of the U.S. Government, 1972, U.S. Government Printing,

In the case of the Environmental Protection Agency, all of its spending was reported under the pollution control and abatement category.[7/]

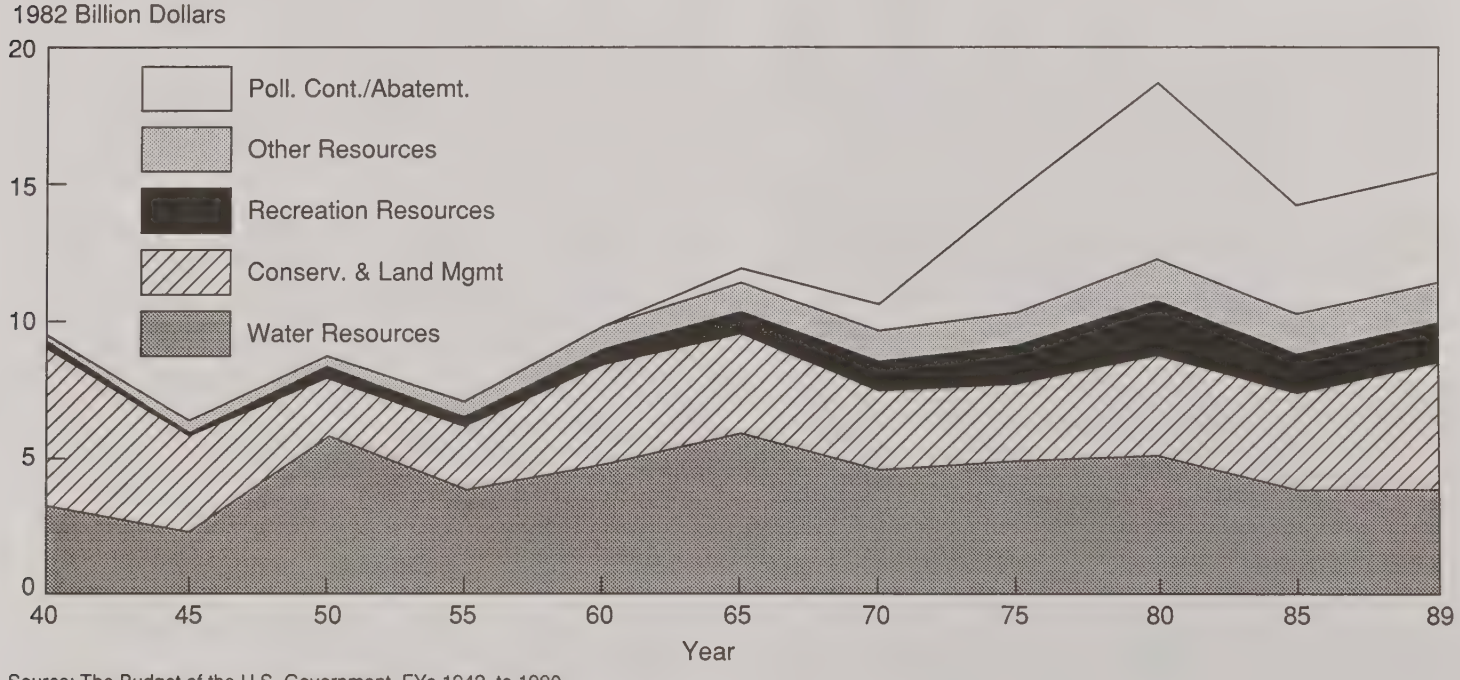
Total gross spending for natural resources and environment reached a peak level of $18.8 billion in 1980, an increase of $8.2 billion in 10 years above the $10.6 billion level in 1970. That is the largest 10-year increase experienced over the 1940-89 period. It was almost entirely for environmental purposes.

At the same time that natural resource and environment spending achieved its historical peak level in 1980, the nation was confronted with double-digit inflation and interest rates along with high unemployment. In the resulting tightening of the Federal budget, both gross and net spending were reduced for natural resources and the environment. By 1985 both were below the 1975 level, but rose again to $15.4 billion and $13.0 billion, respectively, in 1989—primarily due to the billion dollar cost of the Conservation Reserve Program (CRP) authorized in the 1985 Food Security Act. The CRP paid farmers an annual rental plus an initial cost share for conversion of highly erodible cropland to conservation cover and implementation of various other environmental practices on 34 million acres for a 10-year contract period.

Thus, except for the environmental increment after 1970 — a new national priority, both gross and net Federal spending for the traditional natural resource programs remained relatively flat over the 50 years from 1940 to 1989 (table 2). Gross Federal spending for the traditional resource programs averaged $9.6 billion in constant 1982 dollars over this period. Net spending for these programs averaged much less, $7.8 billion, and generally remained below the 1940 net spending level of $9.5 billion throughout the 50- year period (table 2). This relatively flat or stable net-spending trend results in part from a rising level of proprietary receipts from natural resource management activities on Federal lands. These receipts have increasingly dampened the net burden to U.S. taxpayers for Federal gross spending on traditional natural resource programs

The general finding about the relatively flat trend in natural resources funding (excluding the post-1970 environmental increment) in the face of an expanding population, economy, and Federal budget raises a question about the general adequacy of such stable spending. The answer lies both in the performance of the nation's natural resources and in the factors influencing that performance—factors other than the gross Federal spending itself. These aspects of the question are addressed in the next two sections.

Figure 4. Federal Gross Spending for Natural Resources and Environment, 1940-1989



Source: The Budget of the U.S. Government, FYs 1942 to 1990

[7/] Office of Management and Budget, Executive Office of the President of the U.S., "Federal Environmental Programs," Special Analysis, Budget of the U.S. Government, Fiscal Years 1972 to 1980, U.S. Government Printing Office, Washington, D.C.

Changes in the output, use, and condition of natural resources are indicators of their performance in response to the growth of the nation's population and its economy and the public's sense of their social value. Such indicators are generally sufficient, but essentially intrinsic, measures of resource and environmental performance. They do not reveal resource performance in relation to other national goals and policies which define the fuller spectrum of our needs and aspirations for national fulfillment as well as our needs for national growth and development. This spectrum of national goals and policies is broadly outlined below to identify a framework of understanding for such comparisons of performance without attempting to make such comparisons. Some of the goals and policies had their origin in the depressed times and international conflicts of the 1930's and 1940's. Others emerged in the following years. They were an important part of the setting in which natural resource goals and policies evolved and were addressed.

In approximate historical order, this spectrum of goals and policies includes:

- Full employment and economic growth with assurance of income security and retirement benefits.
- Containment of totalitarian aggression for a lasting world peace.
- A decent home, expanded home ownership, and suitable community development for a growing and more mobile population.
- Development of an efficient domestic transportation system.
- Fulfillment of civil rights and equal opportunity.
- Effective science and technology for space exploration.
- Amelioration and elimination of poverty.
- Strengthening the role of State and local governments.
- National environmental quality protection focusing on clean air and waters, hazardous waste control, and biological sustainability.
- Decent medical care for every citizen, especially for the elderly.
- Control of excessive inflation.
- Reducing the annual budget deficit of the Federal Government.
- Others relating to objectives such as reduction of crime and drug abuse, improved communication systems, energy security, and higher educational performance.

There is measurable progress in most, if not all, areas. Complete fulfillment probably eludes all in varying degrees. National persistence probably characterizes the pursuit of each.

Goals and Policies for Natural Resources and the Environment

The five decades from 1940 to 1989 were characterized by major increases in the levels of demand and changes in the relative mix of the traditional products and uses of the natural resources. Both types of change were supported by the marketplace and national policy. The changes affected timber and range forage production, recreation, wildlife and fisheries use, and water storage for irrigation, power, and recreation as well as for urban consumption and industrial use.

This period of changing levels and mixes of resource demands was typified by the emergence of new policies for land use and management and the intensification of traditional efforts for the protection of forests, wildlife, and rangelands; for the conservation of soil, water resources, and wildlife and fisheries habitats; and for the preservation of wilderness, wild and scenic rivers, and natural beauty. New goals were established for a National Wilderness Preservation System as well as new guidelines for multiple use and sustained yield management of Federal lands and renewed efforts to purchase and expand other Federal, State, and local lands for park and recreation purposes. New legislation was enacted for the designation of National Recreation Areas, National Wild and Scenic Rivers, and National Recreation Trails and for the protection and preservation of cultural artifacts of our national heritage.

The most unique and innovative goals and policies were those providing for the protection of environmental quality. This era will probably be noted for its national goals and policies for air quality and water quality, the protection of endangered wildlife and plant species, and the protection and enhancement of sensitive areas such as coastal zones, wetlands, and riparian areas.

The Natural Resources and Environmental Response

The response of the natural resources and the environment to the increased demands for traditional as well as new products and uses and to the new policy direction for environmental quality protection is revealed by many measures and indicators. These are briefly reviewed here and tersely documented by resource category.

Land Use. In 1945, only four areas and 1.4 million acres were formally designated as wilderness. These were on the national forests where an additional 13 million acres classed as primitive lands were also being considered by the Forest Service for wilderness protection and management. Today the National Wilderness Preservation System includes over 90 million acres. The National Park System was enlarged from about 20 million acres in 1940 to nearly 80 million acres in 1985. In addition, 31 National Recreation Areas of 20,000 acres or greater were established near major population centers. State parks more than doubled to 10 million acres in the same period. Municipal and county park and recreation areas tripled to 5.8 million acres in 1986.[8/]

Other land use adjustments and designations include 7,709 miles of National Scenic and Wild Rivers in 75 separate river segments designated by the Federal Government. States report 6,000 additional miles which they have placed under some type of protection to preclude uses that conflict with public access for recreation. In 1988, there also were 14 designated National, Scenic, or Historic Trails stretching more than 23,500 miles and 776 National Recreation Trails totalling 8,100 miles recognized by the Secretary of the Interior. On national forests, 100,000 miles of trail were available for recreation use.[9/]

Forests. From the late 19th century to the early 1930's the area of forest land annually burned by wildfires regularly exceeded 30 million acres. Much of this acreage was harvested land so the wildfires impeded prompt regeneration and made reforestation by tree planting a high-risk investment. Wildfires also damaged watersheds and destroyed wildlife and their habitats. As Federal and State protection programs were strengthened cooperatively beginning in the 1930's, the area burned was rapidly reduced to less than 5 million acres by the end of the 1950's (figure 5). In the 1960's the annual area burned averaged less than 4 million acres a year. In the 1970's and the 1980's, the average annual burn was further reduced to less than 3.0 million acres.

Except for 1963, the annual forest area burned has been kept consistently below 6 million acres for over 30 years, despite intermittent years of severe drought and extreme fire hazard. Annual damages from wildfire have averaged less than 4.0 million acres. This has been a major victory in the protection of the nation's forests, especially since the total fires reported remained within the same range, between 100,000 and 200,000 a year since 1940.

As the risk of loss from wildfire was reduced, tree planting expanded steadily. The acreage planted, including the work of the CCC's, rose to a half million acres in 1940 and remained at that level through 1950. As fire protection continued to improve, the level of planting tripled to 1.5 million acres by 1970. In 1989, the area planted reached 3.0 million acres (figure 6). Most of the tree planting since 1950 was done on private lands where the bulk of tree harvesting occurs—44 percent of the planting occurred on forest industry lands, which constitute only 15 percent of the nation's timberlands, and 36 percent occurred on other private lands, which make up 57 percent of our timberlands. Tree planting on other private lands was significantly enhanced between 1956 and 1965 by the Soil Bank Program and by the CRP between 1985 and 1989. Forest management generally improved on all forest ownerships, with the greatest progress on public and forest industry lands.

The national timber harvest steadily increased between 1952 and 1986, from 13.9 billion cubic feet to 16.5 billion cubic feet (figure 7). Timber growth exceeded harvest throughout this period. It rose from 13.9 billion cubic feet to 22.5 billion cubic feet (figure 7). As a result, timber inventories actually increased in this period of record timber harvest levels, from 610 billion cubic feet to 737 billion cubic feet (figure 8). This successful performance, furthermore, was achieved while the nation's timberland area declined 5 percent, from 509 million acres to 483 million acres, in response to shifts in land use to wilderness and park areas as well as to urban and agricultural use. Between 1977 and 1987, the total area of forest land, which is somewhat greater than the timberlands area, stabilized; it is now increasing, particularly in the private sector, with the expanded planting of trees on highly erodible cropland under the CRP authorized in the 1985 Food Security Act.[10/]

Wildlife and Fish. State wildlife management programs thrived as Federal assistance under the Pittman-Robertson Act of 1937 expanded rapidly after World War II. This expansion was supplemented for the protection and management of sports fisheries with the passage of the Dingell-Johnson Federal Aid in Fish Restoration Act of 1950. Federal assistance to States, measured in constant 1982 dollars, rose from $14 million in 1947 to $95 million in 1984. States were enabled to purchase 4 million acres of wildlife habitat and obtain leases and cooperative agreements for wildlife management on 4,400 areas, totalling almost 40 million acres on public and private ownerships in all 54 States and territories. Practically all of this acreage was available for

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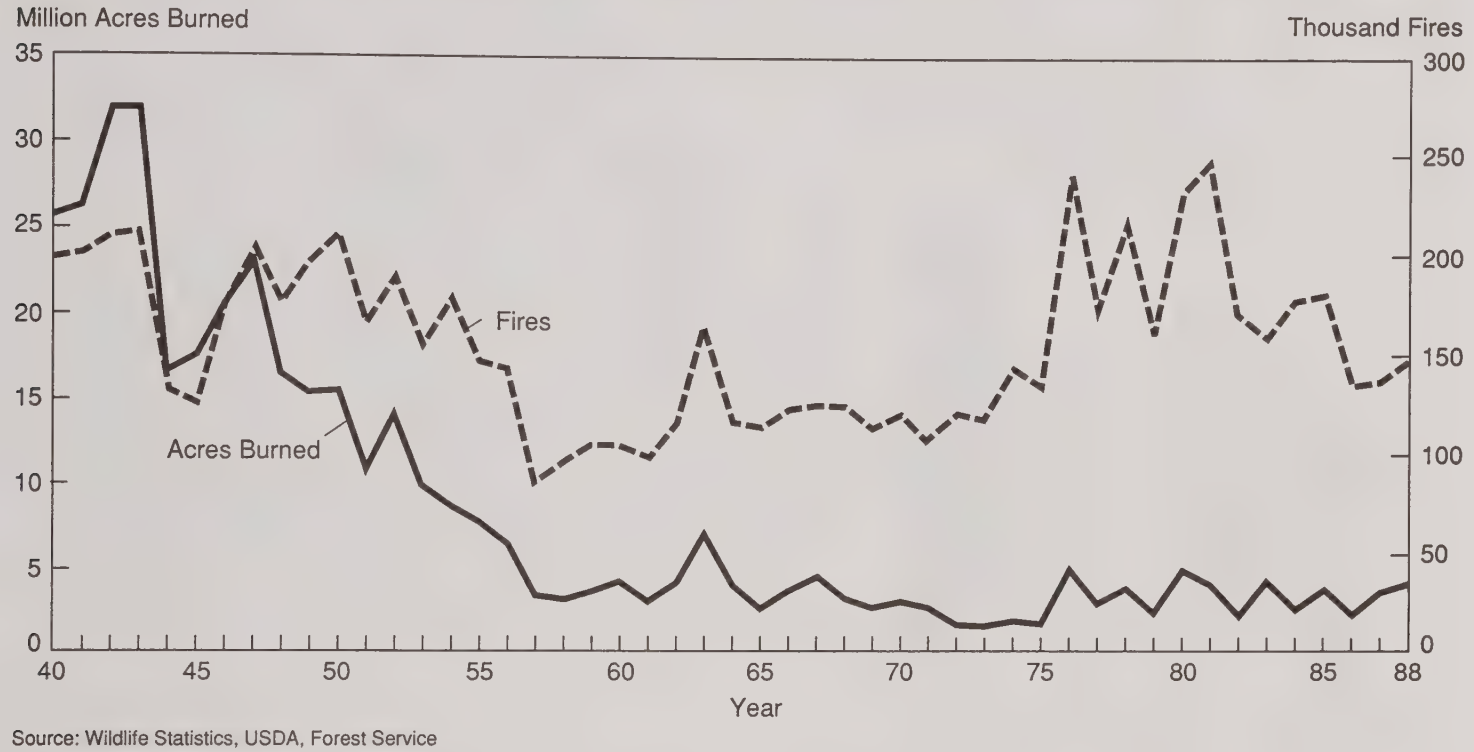
[8/] Domestic Policy Council, Executive Office of the President, 1988, Outdoor Recreation in a Nation of Communities, A Report of the Task Force on Outdoor Recreation Resources and Opportunities, U.S. Government Printing Office, Washington, D.C.

[9/] Ibid.

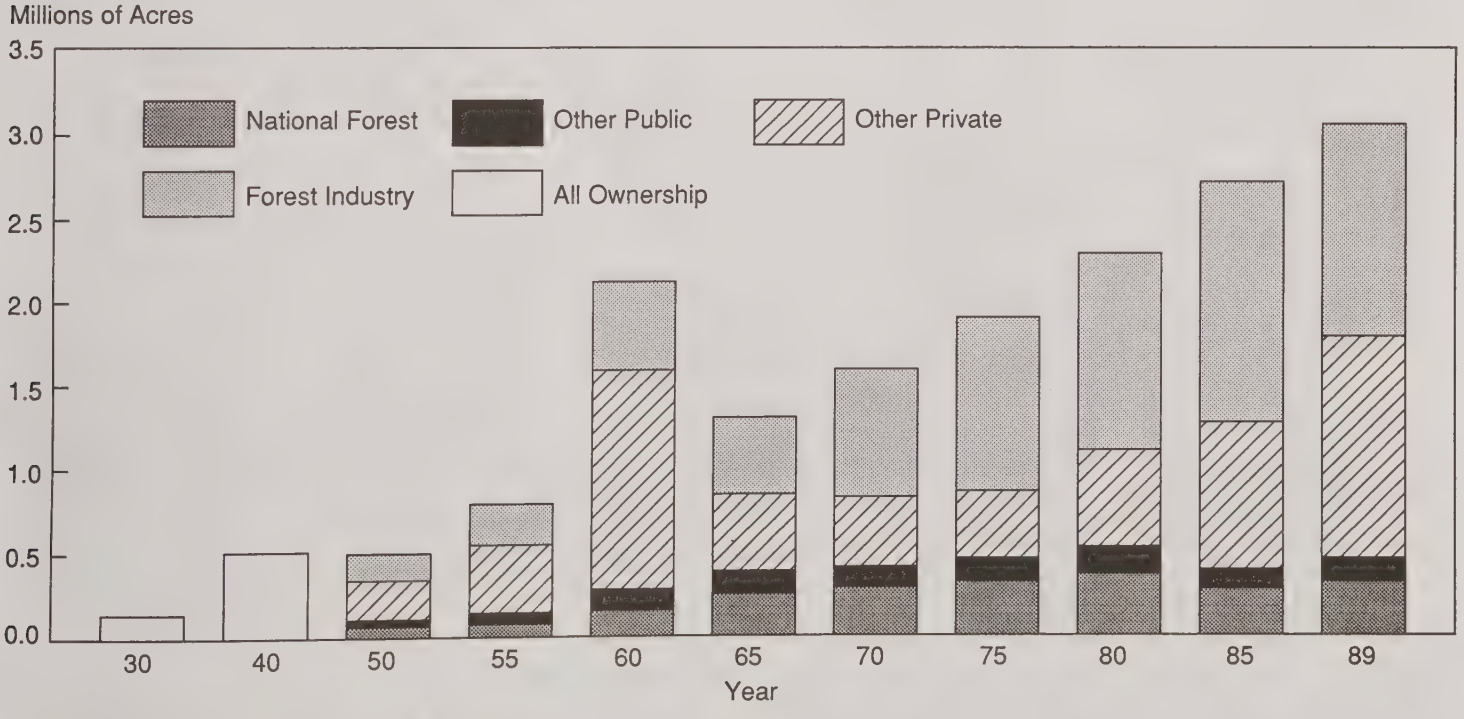
[10/] U.S. Department of Agriculture, Soil Conservation Service, 1987 National Resources Inventory, Summary Report, Table 2, Stat. Bull. No. 790, Iowa State University Statistical Laboratory, U.S. Government Printing Office, Washington, D.C., 1989.

Figure 5. Number of Fires and Acres Burned on State and Private Lands and National Forests, 1940-1988



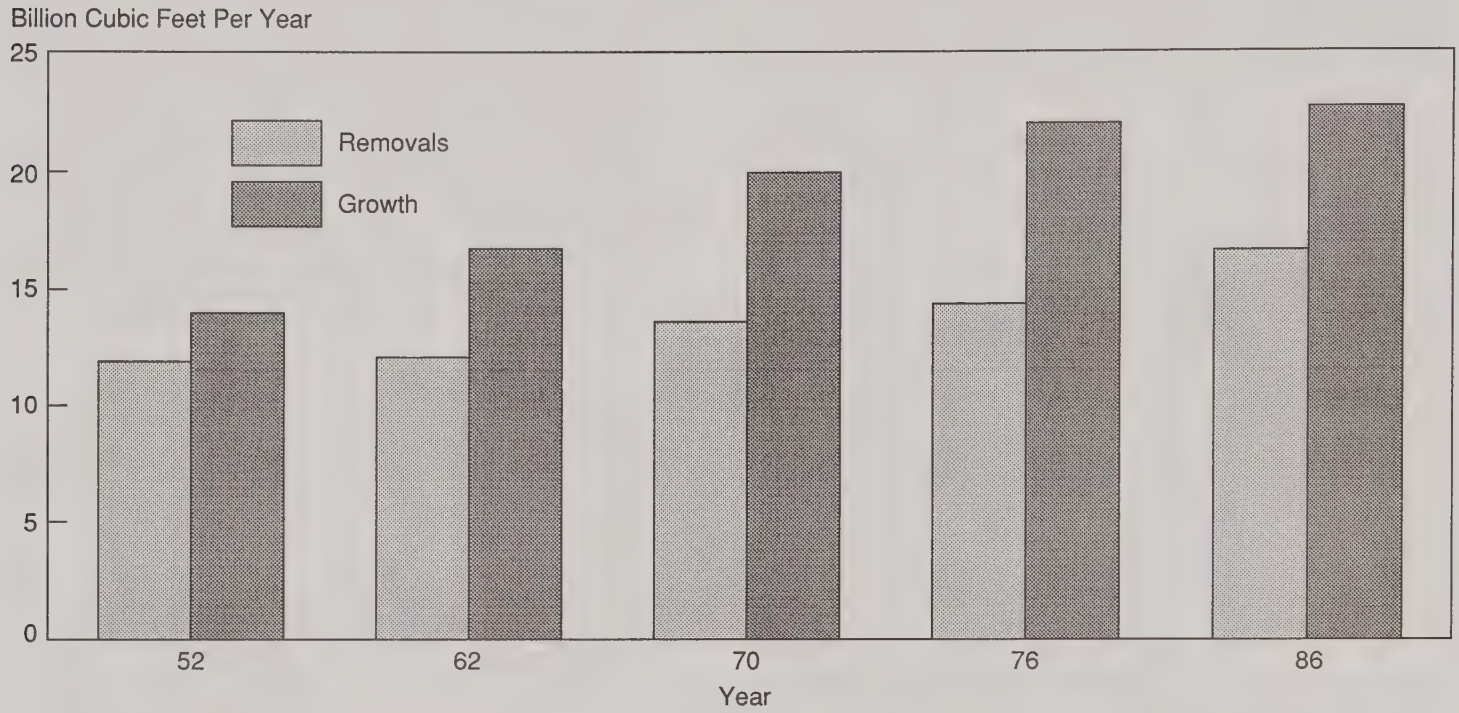
Source: Wildlife Statistics, USDA, Forest Service

Figure 6. Tree Planting in the U.S. by Major Owner, 1930-1989



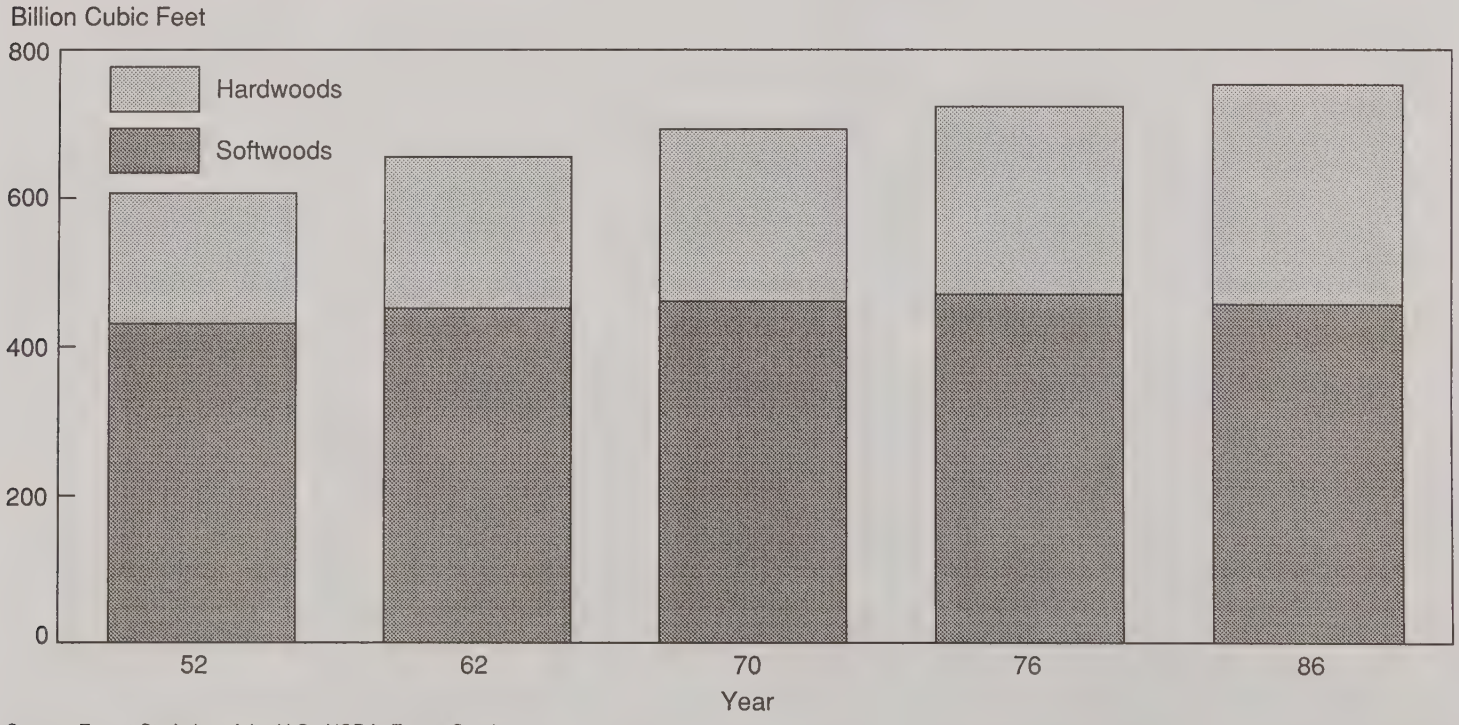
Source: Annual Planting Reports, USDA, Forest Service

Figure 7. Timber Removals and Growth in the U.S., 1952-1986



Source: Forest Statistics of the U.S., USDA, Forest Service

Figure 8. Timber Inventory: Net Volume of Trees on Unreserved Timberland, 1952-1986



Source: Forest Statistics of the U.S., USDA, Forest Service

hunting. In addition, over 560,000 acres were acquired and are being developed or managed as wildlife refuges.[11/]

From 1940 to 1975 the national wildlife refuges more than doubled their number and area, to 378 refugees totaling 32.3 million acres. Their number rose to 477 in 1989 and encompassed over 89 million acres, including large additions in Alaska.[12/]

Large new additions to reservoirs and ponds throughout the 1940-1989 period greatly expanded opportunities for freshwater fishing. Progress has also been made in protecting fishery resources and in mitigating the impacts of hydrologic projects on those resources. The control of point sources of water pollution, particularly after the passage of the 1972 Clean Water Act, has helped to improve and restore fish habitats in many rivers and streams that had been damaged by pollutants. Since the late 1960's when the effluent quality and quantity were at their worst, recreational fishing in the Great Lakes has returned on a large scale and commercial fishing has improved along with water quality improvements.[13/] The number of anglers doubled between 1955 and 1985 and fishing activity days increased even more, 2.7-fold (table 3). The average annual growth rate for both trends substantially exceeded the population growth rate in this period. The number of hunters in the same period increased by 38 percent, slightly less than the population growth rate (table 3). But hunter activity days more than doubled. Since 1975, however, the number of hunters and hunter activity days has declined 5 percent and 13 percent, respectively.

Populations of many birds and mammals have been restored. White tail deer have increased from less than a half million in 1920 to more than 14 million today. Nearly 4 million were harvested in 1980. Wild turkey were scarce outside a few Southern States in 1930. Now they number over 2 million and are hunted in 45 States. Their harvest exceeded 250,000 in 1980. Elk numbered only 100,000 or so in 1920. They now approach half a million with over 75 percent located on national forests. This increase was largely a result of Forest Service wildlife management on western national forests. Similar accounts of population restoration can be cited for the gray and fox squirrels, Canada geese, swans, antelope, beaver, black bear, desert bighorn sheep, mountain lions, bob cats, and many others. The restoration of these populations was also assisted by the expansion of Federal wildlife refuges, which now number 477.[14/]

Table 3. Trends in Fishing and Hunting for U.S. Population 12 Years and Older, 1955 to 1985

Year	Sports Participants		Activity Days	
	Anglers	Hunters	Fishing	Hunting
	Number in millions			
1955	24.9	118	397	169
1960	30.4	146	466	193
1965	32.9	136	523	186
1970	36.3	143	706	204
1975	45.8	171	1058	401
1980	47.0	168	952	349
1985	49.8	163	1065	350

Source: U.S. Department of Interior, Fish and Wildlife Service, 1988, 1985 National Survey of Fishing, Hunting, and Wildlife Associated Recreation, Appendix Table B.3, Comparison of Major Findings of the National Surveys: 1955-1985, Washington, D.C., p. 150.

The 1970's saw a growing management emphasis on protecting nongame species, including the restoration of predator populations such as wolves, panthers, and coyotes. In 1966, the passage of the Endangered Species Preservation Act and subsequent legislation obligated the nation to protect all native animal and plant species whose survival is endangered. Through June 1986, 323 endangered species and 87 threatened species had been identified. Federal agencies are required to manage their resources and programs in ways that do not jeopardize the listed species or damage their critical habitat. The States and many private organizations and landowners have joined hands to assist in protecting listed species. Recovery plans have been developed to protect 233 of the endangered species on Federal, other public, and private lands. One species, the American alligator, among the first to be listed as endangered, has already dramatically recovered in response to temporary restrictions on hunting. Another early listed species, the bald eagle, has tripled its population in 15 years and it too may soon be taken off the endangered listing. This progress may appear to be slow but it is measurable and a tribute both to

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[11/] Council on Environmental Quality, Executive Office of the President, 1987, Environmental Quality, 16th Annual Report, Chapter II, "The Evolving Use and Management of Forests, Grassland and Croplands," U.S. Government Printing Office, Washington, D.C., pp. 123-124.

[12/] Council on Environmental Quality, Executive Office of the President, 1990, Environmental Quality, 20th Annual Report, Table 62, D.C. p. 484.

[13/] Gordon, William G., 1980, "Fisheries", Chapter 9, Natural Resources for the 21st Century, edited by R. Neil Sampson and Dwight Hair of the American Forestry Association, Island Press, Washington, D.C., pp. 205- 207, 231-235.

[14/] Op. cit., Council on Environmental Quality, 1987, p. 124 and Trefethen, James B., 1975, An American Crusade for Wildlife, Winchester Press and the Boone and Crockett Club, New York, N.Y., 409 p.

the nation's policies, commitment, and capabilities and to the resilience of the natural resources and their responsiveness to management. [15/]

Rangeland. Rangelands in the United States total 770 million acres and, like the forests, constitute about a third of the nation's land area. The historical record shows that before the beginning of the 20th century the rangelands were generally overgrazed and depleted due to lack of proper management and serious sustained droughts. When the drought broke and the rains came, about 1905, range forage depletion still continued on about 80 percent or more of the rangelands outside the national forests. The national forest rangelands improved in response to Federal management under the Forest Service, which was instituted in 1905. Private lands and public domain lands appear to have reached their lowest condition during the Dust Bowl days of the 1930's. [16/]

Today, 80 percent of the rangelands are reported to be in fair, good, or better condition. This is attributed to average or better rainfall since the 1930's and to improved knowledge and management of range forage production and use. The range is now considered to be in its best condition since the beginning of the this century for all major ownerships. About 80 percent is in a stable or improving condition. The condition for the other 20 percent is rated as trending downward or unknown and classed as poor or bad condition. [17/]

The total number of cattle increased through most of the 1940-89 period, rising from 86 million in 1945 to 132 million in 1975 even though the total rangeland declined. After 1975, cattle numbers declined to their current level of less than 100 million as beef consumption per capita dropped from more than 90 pounds in 1976 to less than 80 pounds in recent years. Beef cows increased from 16 million to 46 million in 1975, then declined to 34 million in 1986. In the same period, milk cows declined steadily from 28 million to 11 million as milk production efficiency per cow rapidly rose. On national forest lands grazing use was reduced from 9.8 million animal unit months (amount of feed required for a 1,000 lb. animal for 1 month) in 1945 to 8.8 million in 1985. On Bureau of Land Management lands, which were in much poorer condition in 1945, the reduction went from 17.8 million animal unit months to 11.2 million during the same period. Grazing on Federal lands now represents about 7 percent of the total livestock forage grazed and serves 2 percent of the 1.6 million cattle producers in the United States. [18/]

Soil Erosion on Cropland. The serious sheet and rill erosion on cropland and the Dust Bowl wind erosion during the Depression years have largely been corrected or contained. Quantitative data on amount of erosion reduction related to this effort of the 1930's are not available for national or even regional estimates. The findings of a series of soil erosion studies in western Iowa may be indicative of the reduction pattern. The studies found that average annual soil losses per acre dropped from 21.1 tons in 1949 to 19.5 in 1951 and 14.1 in 1957. However, in the early 1970's as cropland planted was rapidly expanding in response to increased export demands, this downward trend was reversed. In 1974, annual soil losses were estimated to be 17.2 tons per acre. [19/]

Soil Conservation Service national survey estimates of cropland erosion indicate an increase in total erosion from 2.6 billion tons in 1967 to 2.8 billion tons in 1977, and to 3.0 billion tons in 1982. [20/] The net increase appears to be attributable to wind erosion since sheet and rill erosion declined from 1.9 billion tons to 1.8 billion tons between 1977 and 1982. This apparent increase in erosion occurred as cropland planted rose steadily from 308 million acres in 1967 to a peak level of 360 million acres in 1981 and 1982.

The expansion of cropland planted after 1967 involved the conversion and planting of much of the erodible grassland and the planting of idled cropland and land withheld from crop production under Federal programs. In addition, the area planted to row crops increased 50 million acres from 145 million in 1969 to 195 million in 1980. Changes on this scale in so short a period, especially for row crops such as corn and soybeans where sheet and rill erosion per acre tends to be most severe, suggest increases in erosion as a reasonable expectation. [21/]

[15/] Op. cit., Council on Environmental Quality, 1987, p. 124.

[16/] Box, Thadis W., 1990, "Rangelands", Chapter 5, Natural Resources for the 21st Century, edited by R. Neil Sampson and Dwight Hair of The American Forestry Association, Island Press, Washington, D.C., pp. 101-120.

[17/] Ibid.

[18/] Op. Cit., Council on Environmental Quality, 1987, pp. 102-108, and U.S. Department of Agriculture, Forest Service, 1989, RPA Assessment of the Forest and Rangeland Situation in the U.S., FRR 26, Washington, D.C., pp. 20- 23.

[19/] U.S. Department of Agriculture and Council on Environmental Quality, 1981, Conservation Incentive Study.—Leveraging USDA Programs to Accelerate Erosion and Sediment Control on Agricultural Lands, unpublished Report to the President, Washington, D.C., pp. 1-31.

[20/] The methods of estimating national cropland erosion differed among these surveys, so the consistency of these national estimates is uncertain.

[21/] Op. Cit., U.S. Department of Agriculture and Council on Environmental Quality, 1981.

During the same period, however, just as many or more cropland acres were placed under conservation tillage systems, which complement erosion control objectives. Erosion rates under conservation tillage systems may be reduced as much as 60 percent under minimum tillage and 90 percent with no tillage as compared with conventional tillage.[22/]

In 1981, the first USDA National Soil and Water Conservation Program, authorized under the Soil and Water Resource Conservation Act of 1978, established soil erosion control as a top national priority. It targeted erosion control and soil conservation practices on critical problem areas to increase the effectiveness of erosion reduction efforts. The Conservation Section of the Food Security Act of 1985 reinforced this policy with three major provisions to reduce cropland erosion: (a) the Conservation Reserve Program (CRP), (b) the Conservation Compliance Program, and (c) the Sodbuster Program.

The CRP was targeted on the most highly erodible lands and, to date, has converted 33.9 million acres to long-term conservation cover. This conversion on the average reduces soil loss on these lands from 20.9 tons per acre to 1.6 tons when the cover crop is fully established. The total reduction in soil loss constituted by the CRP is estimated at 656 million tons a year.[23/] The Conservation Compliance Program will bring further major reductions in soil erosion as the conservation plans completed for 143 million acres of erodible cropland are implemented in the 1990's by the producers participating in USDA farm programs. By the end of the 20th century, these programs, together with the prohibitions of the Sodbuster Program on converting highly erodible lands to cropland production, should reduce cropland erosion to the lowest levels in 100 years.

Water Resources. The nation's water infrastructure today is the most extensive and elaborate system of water projects and management on Earth. It includes more than 80,000 dams; 25,000 miles of inland and intracoastal channels supported by over 200 locks and dams; tens of thousands of groundwater pumps; millions of miles of canals, pipes, and tunnels; and 13 million private and community wells for drinking water purposes. In addition, flooding has been controlled and greatly reduced on many rivers and streams, making their use as sources of water for off-stream purposes and for commercial navigation more dependable.[24/]

Most of the nation's water infrastructure was built or improved during the 1940-89 period in response to the doubling of population, major shifts in regional population distribution, and a quintupling of economic growth. In 1945, the number of moderate- to large-capacity dams totalled 5,135. During the period of most rapid national growth, 1945 to 1969, over 35,000 new dams were added; storage capacity nearly tripled, from 279 million acre feet to753 million acre feet.[25/] The stored waters served to control floods and maintain adequate and stable supplies of water for drinking, industrial and other urban uses, irrigation, hydroelectric power generation, thermoelectric power use, and expansion of several forms of recreation including boating, fishing, swimming, and a variety of amenity uses.

Indicative of the growth of demands for fresh water are the statistics on withdrawals and consumptive use in table 4. Total withdrawals from streams and reservoirs more than tripled from 1940 to 1980 with significant increases in all major use categories. The largest increases occurred for thermoelectric power purposes, reflecting mainly the development and growth of nuclear power plants. Withdrawals for thermoelectric power use first exceeded those for the irrigation of agricultural crops in 1965.

Table 4. Estimated Water Use in the United States, 1940-1985

Use	1940	1950	1960	1970	1980	1985
	Billion gallons per day					
Withdrawals						
Irrigation	71	89	110	130	150	140
Thermoelectric Power	23	40	100	170	210	190
Other Industrial Use	29	37	38	47	45	31
Public Supply	10	14	21	27	34	37
Rural Domestic and Livestock Use	3	4	4	5	6	8
Total	136	184	273	379	445	406
Consumptive Use	n/a	n/a	61	87	100	92
Instream Use						
Hydro Electric Power	n/a	1,100	2,000	2,800	3,300	3,100

Source: Adapted from Kenneth D. Frederick, 1990, The Nation's Water Resources, Discussion Paper, Resources for the Future, Washington, D.C. (n/a means not available)

22/ Op. cit., U.S. Department of Agriculture and Council on Environmental Quality, 1981.

23/ U.S. Department of Agriculture, Agriculture Stabilization and Conservation Service, 1990, "LOGO-PACKAGE," Conservation Reserve Package, January 22, 1990, Washington, D.C., p. 10.

24/ Frederick, Kenneth D., 1990, The Nation's Water Resources, Discussion Paper ENR 90-02, Resources for the Future, Washington, D.C., p. 123.

25/ Frederick, Kenneth D., 1990, The Nation's Water Resources, Discussion Paper ENR 90-02, Resources for the Future, Washington, D.C., p. 123.

In 1985, water withdrawals dropped 10 percent below the 1980 level. This decline occurred in all major use categories except public supplies and rural and domestic livestock uses. Lower withdrawals benefited instream flows.

Consumptive use reflects the amount of withdrawals not returned to a usable ground or surfacewater source. It has consistently averaged about 23 percent of withdrawals. Per capita withdrawals increased from about 1,000 gallons a day in 1940 to 1,950 gallons in 1970, then declined to 1,700 gallons in 1985. Per capita use for public supply and rural domestic and livestock use grew consistently from about 100 gallons a day in 1940 to almost 200 gallons in1985. Thus, the irrigation, thermoelectric power, and industrial uses accounted for the bulk of the increase in withdrawals. Irrigation, however, was by far the largest consumptive user, accounting for more than 80 percent of total consumption.

Water Quality. Water quality generally declined after World War II as the discharge of pollutants and wastes into U.S. waters increased with rapid population growth, increasing urbanization, and expanding industrial production. Nevertheless, the conventional wisdom that water problems, including declining water quality, could be solved through technological change or with the building of another reservoir, treatment plant, levee, dam, or canal seemed to prevail through the 1960's. The technical and physical capacity to manage water for human uses rose dramatically in the first six decades of this century. For example, the availability of safe drinking water for public systems became largely taken for granted following the introduction of chlorination in 1908 and the establishment of national drinking water standards by the U.S. Public Health Service in 1914.[26/]

Rising public concern about the quality of the nation's water in the 1960's, however, led to passage of the Clean Water Act in 1972. That act set goals for restoring all navigable waters to a "fishable and swimmable" (basically recreation use criteria) condition through the regulation of effluent standards for discharges from industrial and municipal pipes and ditches into surface waters; such discharges were then considered the primary threat to the nation's waters. Progress in regulating point sources of pollution has brought major improvements in the quality of the nation's waters. Numerous streams and lakes are once again suitable for outdoor recreation. The Potomac River near Washington, D.C., is an outstanding example. Closed to fishing and water-contact activities in the 1970's, the Potomac is now used by many windsurfers, water skiers, and anglers.[27/] The doubling of the number of anglers and the even greater increase in days of fishing activity since 1955 are further testimony to this improvement (table 3). However, a significant part of the growth in fishing activity is also attributable to the development of major dams and reservoirs for multiple purposes, including recreation use.

Public drinking water supplies have remained essentially safe and potable under strengthening Federal standards, monitoring, and regulation implemented by the Environmental Protection Agency (EPA) since 1970. As the threat of heavy metals, pesticides, and other toxic chemical pollutants emerged in the 1970's, the Safe Drinking Water Act of 1974 was passed. It charged the EPA and the States to require water suppliers to limit contaminants in drinking water. A 1986 amendment specified 83 contaminants for EPA regulation.[28/]

Only a very small fraction of the nation's vast groundwater resources are known to be contaminated in ways that do not meet Federal and State standards for drinking water.[29/] Nevertheless, the potential for contamination is sufficiently documented to identify various sources of potential contamination. Federal and State programs and regulations are addressing these threats in ways designed to prevent unacceptable contamination in the future.

As major improvements have been made in the quality of U.S. waters through the regulation and control of point sources of pollution, national attention has turned increasingly to the management and control of nonpoint sources and the remediation or prevention of their unacceptable impacts on both surface and ground water. Increasing attention is also being directed to the quality of the nation's coastal waters and estuaries.

Outdoor Recreation. The role of natural resources in meeting the explosion in post-war demand for outdoor recreation is reflected in the designation and expansion of land and resources for use as wilderness, parks, trails, and recreation areas. The designation of wild and scenic rivers and development of water resources and winter recreation sites paralleled the land use adjustments for meeting the demand for outdoor recreation opportunities. A major growth of recreation facilities and improvements, including roads and trails for access and dispersion of use, enhanced the number and often the quality of opportunities for camping, boating, hiking, swimming, skiing, hunting, fishing, driving for pleasure, and a host of other outdoor activities. These facilities

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[26/] Ibid. p. 27-29, 58 and 67

[27/] Cordell, H. Ken, John C. Bergstrom, Lawrence A. Hartman and Donald B.K. English, 1990, An Analysis of Outdoor Recreation and Wilderness Situation in the U.S., 1989-2040, a Technical Document supporting the 1989 USDA Forest Service RPA Assessment, General Technical Report RM - 189, p. 89.

[28/] Op. cit., Frederick, Kenneth D., 1990, pp. 71-75.

[29/] Ibid. p. 91

have contributed to the enormous rise in outdoor recreation activities on Federal, State, local community and private lands.

Visits to Federal lands rose from about 50 million a year in the early 1940's to more than 300 million by 1960. At State parks, which had a much smaller acreage, visits rose to 260 million in 1960, 480 million in 1970, and 660 million by 1984. On the Federal lands, the measurement of visits was changed in 1965 from counting number of users entering a site to calculating visitor days (12 total hours of use of a site by one or more visitors) to provide consistency in counting the actual visitor use of Federal sites. On the average, a visitor day is equivalent to several individual visits. In 1965, Federal agencies reported 300 million visitor days of use. This use rose rapidly to a peak level of 570 million by 1976 and then declined steadily to 521 million in 1984. By 1987, however, visitor-day use had re-expanded to 589 million, a new record level for Federal lands. [30/]

Total outdoor recreation in the United States continued to grow after 1976, but at a much slower rate than in the 1950's, 1960's and earlier 1970's. Surveys indicate outdoor recreation is now expanding at about the same rate as population, slightly less than 1 percent a year. [31/]

Most outdoor recreation occurs in the parks and play areas of local communities. Local recreation opportunities account for about 60 percent of all outdoor recreation participation. Federal lands receive about 12 percent of all outdoor recreation participation. State and private lands and enterprises each serve about 14 percent of the participation. [32/]

The Environment. As the use and development of the nation's natural resources expanded in the decades after 1940, the growth and regional shifts in population, urban development, and industrial production led to an increasing flow of emissions and effluents into the nation's atmosphere and waters and the deposition of other wastes, sometimes hazardous ones, on the nation's lands. Some resource management activities were also perceived as affecting the quality of the resources and environment. These included the extension of road construction and timber harvest into old-growth forests on public lands, the reduction of habitats of certain wildlife and plant species, and chemical residues from various pest control and fertilization activities that appeared in our waters and soils.

In 1970, the mounting public concern about environmental conditions culminated in the National Environmental Policy Act. In the two decades since 1970, this commitment further manifested itself in a dozen major and several dozen minor Federal environmental laws. By 1989, the Federal Government acquired new or added responsibilities for improving air and water quality; protection of drinking water; reduction and removal of solid, hazardous, and medical wastes; strengthened regulation of the use of pesticides and toxic substances; protection of endangered species; assurance of occupational safety and health; coastal zone management; reducing contaminants in the upper atmosphere; and others. States, local governments, the private sector, and the general public have also been strongly involved in implementing these activities.

Twenty years of sustained effort have brought identifiable improvements and measurable progress, albeit uneven, in many dimensions of this broad environmental front. When environmental trends data are taken as a whole, they suggest that over the past two decades the United States has been generally successful in protecting and improving environmental quality. Progress has been greater where problems have been widely understood and their dimensions and causes clearly defined. Where the understanding and the dimensions and causes of perceived problems have emerged slowly, or where the sources were diverse and widely dispersed, progress has been more difficult and come more slowly.

The 1989 Environmental Trends report of the Council on Environmental Quality (CEQ) updated a similar 1981 report on the measurable progress achieved for many dimensions of the environment. [33/] The following selected abstracts from the summary of the 1989 report provide a useful overview.

- Mineral and energy industries have made great strides to reduce pollutants and their impact; but some challenges remain.

- Water supplies are sufficient to meet competing uses in most regions despite drought, some shortages, overdrafts, saltwater intrusion, and quality loss in certain places.

- Air and water pollutant loads are being reduced but pollution concerns nevertheless remain. Globally, greenhouse gases are increasing.

[30/] Op. cit., Domestic Policy Council, Executive Office of the President, 1988 and Op. cit., Cordell, H. Ken et al., 1990, table 8, p. 31.

[31/] Op. cit., Domestic Policy Council, Executive Office of the President, 1988, p. 61.

[32/] Op. cit., Cordell, H. Ken, et al., 1990, p.31.

[33/] Council on Environmental Quality, Executive Office of the President, 1989, Environmental Trends, U.S. Government Printing Office. Washington, D.C., pp. vii-viii.

- Wetlands continue to decline, but the rate of loss may be slowing.

- Soil erosion continues to be a challenge in places; but millions of acres of highly erodible cropland have been placed in conservation reserves.

- Parks, refuges, wilderness areas, and wild and scenic rivers have been increased but visitor impacts appear to be rising. Biological diversity is a rising concern worldwide. Although very few species of vertebrates have been declared extinct in the past 30 years, many have been declared threatened or endangered. Some recovery is now reportable.

- The prognosis for improving environmental quality and reducing human risk is good.

- Pollution control and environmental safeguards implemented since 1970 have provided measurable progress in many aspects of the environment.

- Increased public awareness and more attention to environmental conservation have helped to improve the nation's environmental quality.

- But there is more to do.

Although all the problems and goals that have been identified and established for the nation's natural resources and environment have not been solved or fully achieved, it is abundantly clear that they have served the nation's growing population, economy, and public sense of resource and environmental values quite well. Both the resources and the environment they provide have shown a strong natural resilience and responsiveness to management. Americans have proven to themselves that they are both willing and able to respond to the resource and environmental problems, set goals, and improve both the performance and condition of their resources and environment.

The Chairman of CEQ, in his introduction to the 20th Annual Report to the Congress on Environmental Quality, observed that, "Over the past two decades the presumed linkage between economic growth and environmental degradation has been broken." He cited the stabilization of energy use and C02 emissions as the economy grew by 70 percent in real terms since 1970 as exemplifying this new understanding. But other examples could have been used to make the same point. He summed up these observations with "We know now that a growing economy and a clean environment can go hand in hand."[34/]

[34/] Council on Environmental Quality, Executive Office of the President, 1990, "From the Chairman," Environmental Quality, 20th Annual Report, Washington, D.C., pp. ix-xi.

This section addresses the question "How has the reported and measurable progress in natural resources performance been achieved or achievable with more or less stable total Federal funding for the traditional resource programs since 1940?" The relative role of the Federal environmental spending increment since 1970, however, is examined first before the natural resources performance question.

The Environmental Spending Component Since 1970. Pollution control and abatement became the largest component of Federal spending for the natural resources and the environment after 1970 (table 1). The progress in pollution control and abatement, insofar as spending was involved, was largely achieved by the private sector as shown in table 5 for the period 1972 through 1987.[35/]

Table 5. Total Spending for Pollution Control and Abatement by Economic Sector, 1972-1987

Economic Sector	1972	1975	1980	1985	1987
	1982 dollars in billions				
Personal Consumption	3.3	5.9	7.2	11.3	10.4
Business	28.0	32.6	39.2	42.9	45.5
Government	11.7	15.0	15.7	13.9	15.5
Total	43.0	53.5	62.0	68.1	71.4

Source: Farber, Kit D. and Gary L. Rutledge, "Pollution Abatement and Control Expenditures, 1972-1984," Survey of Current Business, July 1986 and "Pollution Abatement and Control Expenditures, 1984-87," Survey of Current Business, July 1989.

Annual spending for pollution control and abatement increased by $28.1 billion in this period; 87 percent of the increase came from the private sector. Thus, the private share rose from 73 percent in 1972 to 78 percent in 1987. The Federal, State, and local government share declined accordingly as the public spending level tended to stabilize around an average of $15 billion a year.

The growth in total spending to 1980 largely reflects the impetus of new environmental legislation and regulations for clean air and water. The economic recession from 1980 through 1982 induced a 7-percent decline after1980 but spending resurged after 1982 with renewed economic growth and increased governmental regulatory activity for the environment.[36/] Figure 9 shows how the total spending was allocated by resource objective or functional purpose.

Personal consumption spending for pollution control and abatement more than tripled in this period and made up 29 percent of the increase in private spending. It includes the cost of motor vehicle emission abatement devices and the added cost of using unleaded rather than leaded gasoline in vehicles with catalytic converters. The purchase of abatement devices constituted two-thirds to three-quarters of this spending.

Business spending rose at a slower rate than consumer spending, but made up almost two-thirds of the total increase in pollution control and abatement spending between 1972 and 1987. It includes capital spending for motor vehicle emission abatement devices, plant and equipment, and associated operating costs plus the operating costs of public sewer systems.[37/] Business capital and operational spending were about equal in the early 1970's. Annual capital spending by business remained stable at about $15 billion throughout this period while operating costs rose to more than $30 billion in 1987. Business also accounted for two-thirds of the research and development spending.

Government spending includes all of the Federal, State, and local government regulation, monitoring, research and development, and the capital costs of public sewer systems. Public sewer systems regularly made up somewhat more than half of all Government spending.

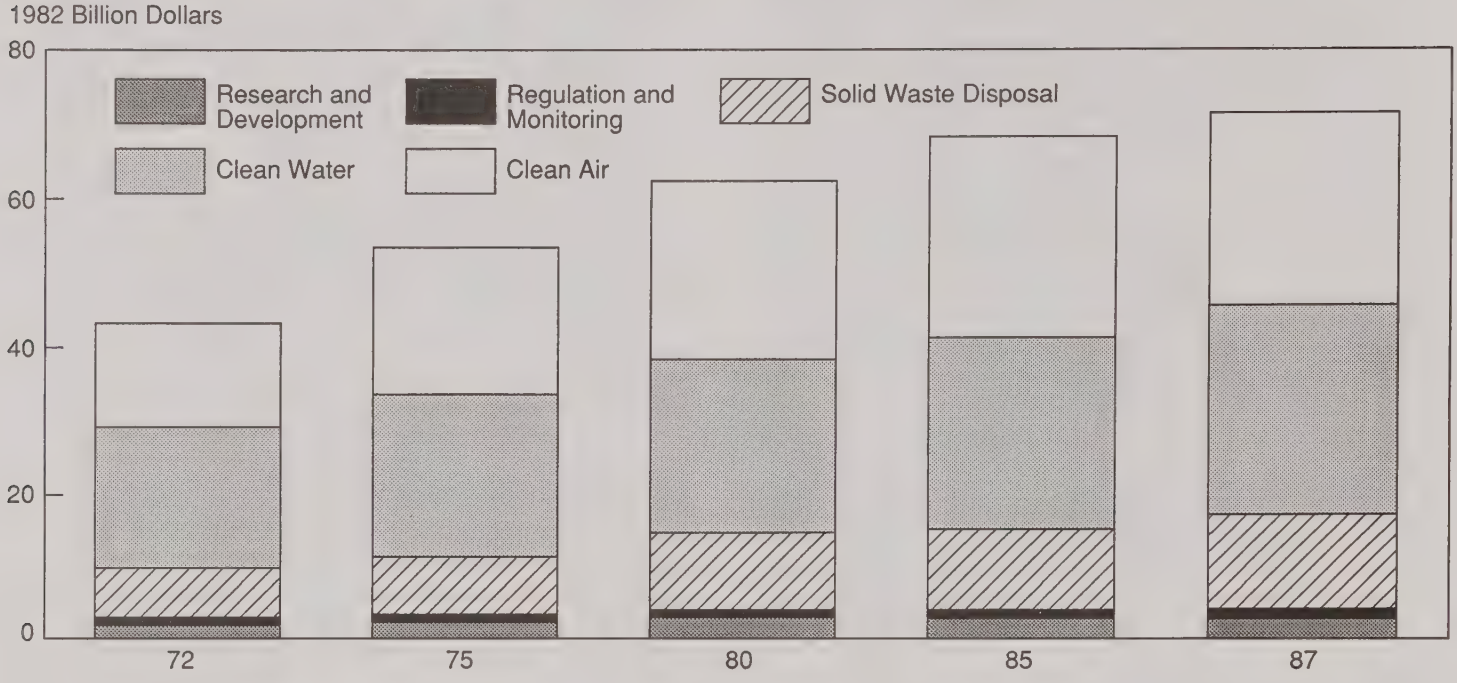
Thus, most of the progress in reducing air and water pollution and solid wastes has been achieved by the private sector. The Federal role has been to set goals, establish regulations and standards, and provide incentive grants to States and communities for public sewer system construction and waste disposal. Even then, the comparison of Federal pollution control and abatement spending in table 1 with all government spending for pollution control and abatement shown in table 5 indicates that the latter is largely State and local government spending.

[35/] In table 5, spending is for goods and services used by U.S. residents to produce cleaner air and water and to dispose of solid wastes. It includes three activity components: (a) government regulation and monitoring that stimulates and guides action to reduce pollutant emissions; (b) public and private pollution abatement activities that directly reduce pollutant emissions by preventing their generation, recycling them, or treating them prior to discharge, and (c) public and private research and development to increase efficiency in all these activities.

[36/] Farber, Kit D. and Gary L. Rutledge, 1989, "Pollution Abatement and Control Expenditures, 1984-87," Survey of Current Business, July 1989, p. 20.

[37/] The operation of public sewer systems is classed as government enterprise and business spending in the national income and product accounts. The capital costs of facilities, however, are accounted as government spending. Public sewer systems include treatment plants, collection and interceptor sewers, pumping stations, and dry waste disposal plants.

Figure 9. Pollution Control and Abatement Spending by Resource Objective or Functional Purpose, 1972-1987



Source: Op. Cit., Table 5

Federal pollution control and abatement spending rose to a peak of $6.5 billion in 1980 and then declined to about $4.0 million during the rest of the 1980's. Over the 20 years 1970 through 1989, it averaged $3.98 billion (table 1), about 28 percent of the total government spending shown in table 5.

Gross spending for environmental purposes within the traditional natural resource programs rose about 2 billion dollars from 1970 to 1980, according to the Special Analyses of the Budget of the United States Government for the years 1972 to 1980. This spending, like that for pollution control and abatement, likewise declined after 1980 as Federal domestic spending was controlled to contain the rising deficit in the 1980's. The increment of spending for environmental purposes for the 20 years 1970 through 1989 averaged about 1 billion dollars a year. That spending was directed largely to Federal lands to reduce air and water pollution, solid wastes, and residues associated with Federal resource program activities, and to respond to various other environmental problems perceived to be in the public interest in Federal land management. It constituted somewhat more than a 10- percent increment to the 50-year average spending level of $9.6 billion dollars for the traditional resource programs.

The foregoing spending levels and trends for pollution control and abatement indicate an underlying policy for placing the bulk of the burden of environmental quality cleanup and maintenance upon the producers and sources of pollutant flows rather than on the shoulders of Federal, State, or local government taxpayers. This approach appears to maximize the business and individual private incentives to reduce the flow of pollutants and to strive for efficient costs in their control and abatement at the source.

In retrospect, there can be little doubt that the rising accumulation and growing national dimensions of undesirable and harmful effluents, emissions, wastes, and residues in the nation's atmosphere and waters and on our lands led to and called for a Federal leadership role and regulatory approach to reduce and reverse those trends so widely evident in all parts of the country. The environmental contaminants came largely from localized point sources external to natural resources management and use. They were mainly by-products of major growth and regional shifts in population, accelerating urbanization combined with rapid economic development, technological innovation, and industrial expansion. These were sources that traditional resource managers could not easily address, even though the flow of pollutants affected the natural resources. The lesson to be learned from this experience is that in the future the more effective way to avoid the undesirable influence of contaminants in the environment is to prevent or limit their flows and impacts at their local sources. This principle suggests that Federal spending for pollution abatement and control should decline as the existing problems are increasingly mitigated or controlled locally at their source.

Sources of Progress in the Performance of Traditional Natural Resources

The following sections address the basic question, "How have natural resources progress and improvement been achieved in light of the relatively flat trend in Federal spending for the traditional resource programs?" The role of major factors other than direct Federal expenditures is examined to understand their trends and how they contributed to the performance of the traditional natural resources.

Expanded Knowledge, Science, and Professional Capability. Fundamentally, a great deal of the progress is attributable to the growth of a scientific and professional work force and the accumulation and application of an expanding fund of natural resources knowledge, science, and technology that had its beginning about the turn of the 20th century. This was largely the product of the establishment of natural resources departments and educational programs at State and private universities. The needs of public resource agencies, private resource-based industries, resource associations, and landowners for that knowledge, science, and technology and the professional capability to use it were the essential driving forces for that growth. The result has been a continuing increase in the effectiveness of resource management and protection and in the response of natural resources to that management and protection.

Indicative of the growth in natural resources knowledge, science, and professional capabilities are the trends in degrees conferred by institutions of higher education in the fields of biological, agricultural, and environmental sciences, as shown in table 6.

Total degrees conferred each year by institutions of higher learning rose 5.8-fold between 1940 and 1975 and then more or less stabilized at about 1.3 million a year. All science degrees appear to have grown similarly, with their number hovering at about 300,000 a year after 1975. Degrees offered in the biological, agricultural, and environmental sciences are a broader category than natural resources but they include those sciences and disciplines that address natural resources directly or provide basic or related science support for natural resources management. They appear to have increased somewhat more rapidly than all science degrees and total degrees conferred, based on the rates of growth in degrees conferred between 1966 and 1975. Their growth peaked in 1980 and then dropped off about 20 percent by 1988. In academic circles, this recent decline is attributed to a drop in the expansion of employment opportunities in resource-related fields.

Table 6. Degrees Conferred in Science Areas Contributing to Natural Resources Knowledge/ Science and Professional Capability, 1940-1989.

Science Field/Degrees	1940	1966	1975	1980	1985	1988
			Number in 000s			
Biological, Agricultural & Environmental Science						
Bachelor	n/a	35.9	77.6	77.8	65.4	57.8
Master	n/a	3.3	11.1	12.1	10.9	10.5
Doctorate	0.8	3.1	5.0	5.3	5.5	5.8
Total	n/a	42.3	93.7	95.2	81.8	74.1
All Sciences & All Degrees	59	171.5	309.0	285.3	299.5	295.9
All Fields & All Degrees	216.5	682.7	1,258.3	1,270.4	1,309.4	1,339.6

Sources: National Science Foundation, 1990, Science and Engineering Degrees: 1966-88, A Source Book, NSF 90-312, Washington, DC, 45 p. and 1940 data from U.S. Department of Commerce, Bureau of the Census, Historical Statistics of the U.S., Colonial Times to 1970, Washington, D.C. (n/a means not available).

More explicit data on the growth of scientists concerned directly with natural resources is provided in table 7, which shows doctorate degrees conferred specifically for natural resources disciplines including forestry, wildlife, fisheries, and range. These are compared with doctorates conferred in biological, agricultural (excluding natural resources), and environmental science fields. The number of doctorates conferred specifically in the natural resources disciplines since 1940 appears to have grown significantly faster than doctorates conferred in agricultural, biological, and environmental science areas. However, the number of natural resources degrees conferred is substantially lower than those conferred in the other science areas, even in 1989. This relative trend suggests that bachelor and masters degrees conferred specifically in the natural resources field may likewise have grown more rapidly.

Table 7. Doctorate Degrees Conferred in Natural Resources and Related Biological, Agricultural, and Environmental Sciences, 1940 to 1989.

Science Field	1940	1960-64[1]	1970	1980	1985	1989
			Number			
Natural Resources	[2]	53	122	153	179	215
Agriculture	93	408	682	759	932	873
Biology	610	1,420	3,361	3,497	3,792	4,106
Environment	59	276	498	628	617	738
Total	767	2,157	4,663	5,037	5,520	5,932

[1] Average per year
[2] Included in agriculture; based on percentage relationship with agriculture in 1960-64, a probable estimate would be about 12.

Source: National Science Foundation, 1990, Science and Engineering Doctorates: 1960-89, NSF 90-320, Washington, D.C., 213 p.

Employment of agricultural, biological, and environmental scientists in scientific work is another indicator of the growth in knowledge, science, and professional capability. Trends are shown in table 8 for the 1950 to 1986 period. The data indicate that the employment scientists with degrees in natural resources and related or supporting scientific fields increased more than sixfold between 1940 and 1989. In contrast, the total civilian task force rose only 2.2-fold in this 50-year period. Thus, it seems evident that the knowledge and scientific talent, as well as professional capabilities to manage the nation's agricultural and natural resources, grew more rapidly than the demands placed on those resources by the doubling of population and fivefold increase in economic activity between 1940 and 1989.

More direct evidence of the rate of growth in natural resources knowledge, science, professional capability, and related employment is the trend in memberships in the major professional societies for natural resources as shown in table 9. Membership includes professional resource managers and practicioners as well as those professionals engaged in scientific research and development or educational pursuits. These trends, however, are indicative only because society memberships do not include all practicing professionals.

For the professional societies established before 1940—fisheries, wildlife, and forestry—membership increased fourfold by 1970 and almost sixfold by 1980. Membership in those societies formed after 1940 increased even more rapidly. Total memberships in all six societies increased almost tenfold to 1980 and tended to stabilize thereafter. This is consistent with the decline in degrees conferred in the agricultural, biological, and environmental agencies (table 6) and the apparent decline in new job opportunities in the

Table 8. Scientists Employed in Science Jobs, 1950-1986

Year	Environmental Science[1]	Life Science[2]	Total	Research & Development
		Number in 000s		
1950	23.0	46.0	69.0	n/a
1960	42.0	97.0	139.0	n/a
1970	67.0	173.0	240.0	n/a
1980	63.1	267.3	330.4	108.7
1986	97.3	340.5	437.8	125.2

[1] Environmental science includes earth, oceanic, and atmospheric science.
[2] Life science includes agricultural, natural resources, biological, and medical science.

Source: U.S. Department of Commerce, Bureau of the Census, Historical Statistics of the U.S., Colonial Times to 1970 Washington, D.C. and National Science Board, Science and Engineering Indications-1989, NSB 89-1, U.S. Government Printing Office, Washington, D.C. (n/a means not available).

Table 9. Membership in Natural Resource Professional Societies, 1940-1989

Professional Society	Year Established	1940	1970	1980	1989
			Number		
American Fisheries Society	1870	848	5,359	8,193	9,011
Society of American Foresters	1900	4,556	17,227	21,180	19,051
Wildlife Society	1937	908	5,102	7,785	8,753
Soil & Water Conser. Society	1945	(1,472)	14,222	13,945	12,855
Society for Range Management	1948	(634)	3,832	5,907	5,189
American Water Resources Assoc.	1964	(261)	1,707	2,410	3,421
Total Membership		6,312[1]	47,449	59,420	58,280

[1] Total is only for 1940 data. Data in parentheses is for year of establishment of the society.

Source: Data provided by the national offices of the listed societies.

period since 1980. However, this does not follow the trend in employment of scientists (table 8), which continued to grow after 1980. The membership trend for the American Geophysical Union shown in table 10 may explain the continued growth of scientific employment, particularly in the environmental and earth sciences areas.

Table 10. Membership in the American Geophysical Union by Primary Discipline, 1940-1989[1]

Science Discipline	1940	1973[2]	1989
		Number	
Atmospheric Science	n/a	1,038	2,295
Hydrology	n/a	2,051	4,748
Ocean Sciences	n/a	1,342	4,304
Geodesy	n/a	451	834
Tectonic physics	n/a	836	2,547
Seismology	n/a	1,038	2,341
Vulcanology, Geochemistry, & Petrology	n/a	1,074	2,917
Others	n/a	3,451	5,044
Total	1,400	11,281	25,030
Percent Students	n/a	11.2	16.5

[1] American Geophysical Union was established in 1919.
[2] First year that membership by primary science discipline became available.

Source: American Geophysical Union National Office (n/a means not available).

Membership in the American Geophysical Union (AGU) increased almost eight- fold between 1940 and 1973, somewhat less rapidly than the total membership rise in the traditional resource societies shown in table 9.

Between 1973 and 1989, however, AGU membership more than doubled, while the traditional resource societies grew only 23 percent. Slightly more than half of AGU growth occurred in atmospheric science, hydrology, and ocean sciences. This growth was probably induced by the environmental concerns for air and water quality. This general trend in environmental and earth sciences no doubt contributed to the growth of employment of scientists in science fields as employment in the traditional resource areas apparently slowed.

Not reflected in the foregoing data is the growth of engineers trained and employed in natural resources and environmental protection and management. Data on engineers trained and employed in the renewable resource fields is not readily available. Their role is particularly important in forest and water sources management as well as in soil and water conservation. Data from the Forest Service and Soil Conservation Service in the U.S.Department of Agriculture and the Fish and Wildlife Service in the U.S. Department of Interior show that the employment of engineers in these agencies rose from somewhat more than 400 in 1940 to a peak level of 2,600 in 1970. Engineer employment in these agencies has since declined to 2,200.

The foregoing trends in degrees conferred, employment, and professional resource society memberships make it evident that the 1940-89 period was one of rapid growth in knowledge, science, and professional capacity relating to the protection and management of the renewable natural resources and environment. There is little doubt that this rapid growth responded to demands and opportunities for the use of that knowledge, science, and professional skill. The expansion of knowledge, science and professional capacity has been a major, though not a well understood or documented, factor in the management and use of the nation's natural resources and environment.

Research on the natural resources and the environment is now at its highest historical level, as indicated by the trend in doctoral degrees conferred in natural resources and related sciences and the employment of scientists in the environmental and life sciences. Professional resource managers, specialists, and practitioners working close to the resources are working in larger numbers than ever before in essentially every county of the United States.

Technology and Productivity Improvement. General measures of productivity for natural resources are not yet available. However, much of the technology development and improvement contributing to national productivity growth has also contributed to the productivity of resource management and of the resources themselves. The continuing general improvements in communications, transportation, and computerized information management equipment and systems have reduced unit costs and time requirements generally for all resource management activities. Improved access to the resources, provided by expanded road and trail systems, and the growing technology of aerial photography and remote sensing for data collection and mapping have contributed similar benefits.

Technologies more specific to resource management include tree planters; a vast variety of resource-measuring equipment; site preparation equipment; chemicals for the control of

pests and vegetation; fertilizers; power saws; fire retardants for wildfire control; lower cost road design standards and construction consistent with resource use, management needs, and environmental quality; and various types of earth-moving equipment. New and improved technologies specific to soil and water conservation include:

- conservation tillage equipment and systems that reduce soil erosion;
- electronic snow monitoring to predict water yields;
- shifts in irrigation technology from flooding to sprinkler systems and, more recently, to drip irrigation;
- the lining of canals and storage dams to reduce water percolation;
- systems for recycling and reclaiming water from sewage and other wastewater sources; and
- improved grazing systems that increase effective forage utilization.

Other new and improved technologies include the heli-torch for more effective prescribed burns to reduce forest fuel hazards and to improve wildlife habitats; artificial nesting cavities to protect the endangered red cockaded woodpecker; the "Alaska steep pass" aluminum chute fishladder to get spawning anadromous fish past major stream obstructions; systems for holding, routing, and blending storm sewer drainage with sewage at central treatment plants to improve downstream water quality; and much more. Not included in the foregoing discussion of natural resource management technology are the innumerable biological improvements in the quality and productivity of livestock, grasses, forage, and trees.

Productivity improvement among the natural resources no doubt paralleled that for the nation as a whole, particularly after 1929 with the major expansion in natural resource knowledge, science, professional capability, and technology. The economic growth rate per capita for the nation as a whole has averaged 1.78 percent per year since 1869. This rate was about the same in the 60 years before 1929 and the sixty years following 1929. 38/ It is a measure of average longrun productivity improvement in the U.S. economy. Productivity improvements approaching this magnitude in natural resources undoubtedly contributed substantially to the long-term enhancement of resource supplies and conditions through both the reduction of unit costs of resource management and increases in the responsiveness of the resources to that management.

A few partial indicators are available to support this qualitative assessment of long-term natural resource productivity improvement. Average timber growth per acre, the equivalent of annual crop yields per acre, rose from 27 to 47 cubic feet per acre per year between 1952 and 1987 while the average annual harvest rose from 24 to 36 cubic feet per acre. As a result, timber inventories increased from 610 billion cubic feet to 752 billion cubic feet during that period.

Inventories increased for both softwoods and hardwoods between 1952 and 1986, but over 90 percent of the increase occurred in the hardwood inventory. This performance came in response to improvements in forest protection and management, regional shifts in agricultural land use, and the natural resilience of the nation's forests and forest lands. Despite this improvement in physical productivity, softwood timber demands rose faster than inventories and supply, inducing an increase in relative prices as the rate of the annual softwood harvest rose from 1.8 percent to 2.7 percent of the softwood inventory.

Hardwood demands increased much more slowly so that the ratio of harvests to inventory actually declined from 2.2 percent to 1.7 percent of the inventory. The relative price level for hardwoods as a whole remained fairly stable, although there were some price increases for certain preferred and generally less abundant species. 39/

Unit costs have been compiled and reported systematically in the South for nine forest management practices for 8 intermittent years between 1967 and 1988. Although the unit costs have had a tendency to press upward due to the high proportion of labor costs for several of the management practices, their unweighted average level has tracked closely with the general level of producer prices for all commodities (table 11). That implies productivity improvements in management inputs have been consistent with the general increase in productivity in the industrial sector.

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[38] Stein, Herbert, 1990, "The U.S. Economy: A Visitor's Guide," The American Enterprise, Volume No. 4, July/August 1990, pp. 6-12.

[39] Ince, Peter J., John Fedkiw, Edward Dickerhoof and H. Fred Kaiser, 1989, National Measures of Forest Productivity for Timber, FPL-GTR-61, U.S. Department of Agriculture, Forest Service, Forest Products Laboratory,Madison WI, 13 p.

Table 11. Index of Unit Costs for Forestry Practices in the South, 1967-1988

Index	1967	1974	1976	1979	1982	1984	1986	1988
Average Unit Cost of 9 Practices	31	59	70	78	100	112	108	108
Producer Prices for all Commodities	33	54	61	79	100	104	104	107

Source: Straka, Thomas J., William F. Watson and Mark Dubois, 1989, "Costs and Cost Trends for Forestry Practices in the South," Forest Farmer, 27th manual edition, Vol. 48, No. 5, Forest Farmers Association, Atlanta, GA, pp. 8-14.

The Capital Nature of Natural Resources. The natural resources themselves are capital assets with enormous capacity for production and use. As capital assets, natural resources generate a long-term flow of products, services, use opportunities, and benefits. As highly valuable capital assets, the resources themselves represent the largest part, by far, of the costs of generating their annual flow of products and services. Annual resource spending for resource management and development, a relatively small fraction of the capital value of the resources and their implicit interest costs, falls into two categories (a) operating costs and (b) capital maintenance, replacement, and enhancement costs.

The operating costs are recurring annual expenditures associated with the annual harvest and use of the resource, such as timber sales preparation and supervision, services to recreation and other resource users, permit granting and supervision, fee collections, and related overhead expenses. These expenditures are associated with capturing the benefits of natural resources for human enjoyment, consumption, or further production. In normal accounting these costs are chargeable to the uses and products produced rather than to the resource asset maintenance account.

Capital maintenance costs include regular resource monitoring activities; regular maintenance of improvements including roads, trails, and facilities; and the activities for resource protection. Capital replacement costs are for restoration of resource assets that are harvested, lost to fire or other disasters, or otherwise consumed. These include reforestation, restocking of fish or wildlife, reconstruction or replacement of depreciated or obsolete facilities, and other restoration improvements. Generally, both capital maintenance and replacement spending are chargeable to sustaining the current productivity of the natural resources and the existing flow of products, services, uses, and benefits. These costs, like the operating costs, tend tobe relatively stable year in and year out, except for increases associated with rising annual outputs and the tendency for unit costs to rise as less productive segments of the resources are utilized for current production over time. Productivity improvements in resource management practices, on the other hand, tend to offset such cost increases where they do not exceed 1 to 2 percent a year.

Capital enhancement investment expands the resource capacity to produce products, services, uses, and benefits in the future. Such capacity expansion can be achieved by investments that improve resource productivity or quality, access the under-utilized parts of a resource, or actually expand the total resource. Investments in wildlife and fisheries habitat improvements; tree stand management and fertilization to increase growth; roads and trails to reach unaccessed resources and to reduce losses from fire, insects and disease; storage of water; afforestation of previously nonstocked lands; genetically improved grasses, forages and trees; facilities to increase recreational utility and use; and similar projects are enhancement investments that add to the future flow of products, services, uses, and benefits of natural resources. Such investments ordinarily are chargeable to capital accounts and future production and use.

Long-term trends in resource use indicate a growth rate about equal to population growth, which averaged 1.3 percent a year for the United States since 1900 as well as for the 50 years since 1940. During the last decade, however, population growth has fallen to less than 1.0 percent and is projected to slow to about 0.6 percent in the next 50 years or so. Thus, to the extent that resources management combined with growth in knowledge and technology can improve resource productivity consistent with the long-term trend in national productivity improvement, one would expect spending for resources management to remain relatively stable. Variations in total spending and the mix of spending among resources between years or longer periods, due to changes in short-term population growth rates and in the mix of demands among the resources, could be a normal expectation but consistent with longer term general stability in spending.

A number of factors, however, could alter such a long-term outlook. Such factors would include an absolute decline in the total natural resource base due to natural disasters, urban and industrial development, or long-term neglect of adverse impacts such as was experienced with water quality and air quality after World War II. Restrictions on the full use of the resources for all of their potential by resource development constraints, dedication of resources to preservation or single uses, or the exclusion of public access to resource use have similar effects that could call for increased spending and investment to raise the productivity of the resources available for full use.

Land Use Adjustments. Shifts and adjustments in land use are continuously being made in all ownership classes to respond to relative changes in demand and prices or public preferences among resource products and services. Because of the huge capacity of the resource base, these shifts and adjustments can be made with little change in direct spending. Such land use shifts and adjustments, in terms of public spending, often are low-cost ways to respond to rising demands and more particularly to changes in the mix of demands so long as there is general excess capacity in the resource base or in its more dominant uses. Thus, the reservation of public domain lands in the early decades of the 20th century and, to some extent during the last 50 years, for national parks, wildlife refuges, and wilderness (particularly in Alaska) were low-cost adjustments in terms of public spending.

Where land use adjustments and restrictions reduce the resource base available for current or future net benefits associated with timber growing, range grazing, certain recreation activities, or mineral/energy exploration and development, they can induce opportunity costs in the form of higher consumer prices, loss of jobs, and social adjustment cost of workers and families. On the other hand, the adjustments and restrictions may also produce their own net benefits which can offset part or all of these costs. Such trade-offs, for example, were involved in the designation of 32 million acres of the National Forest System lands for the National Wilderness Preservation System. In some cases, land use adjustments and trade-offs have also increased Federal spending for compensatory payments to displaced workers and operating costs for the resources through their influence on transportation costs and management practices. In other cases, they may have led to management costs that exceeded benefits, as in the case of some "below cost" timber sales on public lands.

Federal Tax Expenditures. Federal tax expenditures attributable to natural resources significantly supplement direct Federal spending for traditional natural resource objectives. They rose from an estimated $375 million in 1974 (constant 1982 dollars) to $1,436 million in 1985, then declined to $839 million as the capital gains tax benefits were withdrawn for timber, nonfuel minerals, and other resource production.[40/] The Congressional Budget Act of 1974 (P.L. 93-344), which provided for the regular reporting of tax expenditures in the budget, defined tax expenditures this way: "revenue losses attributable to provisions of the federal tax laws which allow a special exclusion, exemption, or deduction from gross income or which provide a special credit, a preferential rate of tax, or a deferral of tax liability."

Tax expenditures are one means by which the Federal Government pursues public policy objectives and, in most cases, can be viewed as an alternative to direct budget outlays, credit assistance, or other policy instruments. Tax expenditures for natural resources directly benefit private individuals and business enterprises engaged in resource management. Benefits also accrue to others in the form of lower prices for particular goods or services, or in other ways become widely diffused. For example, the exclusion of interest on State and local pollution control and abatement bonds and 5-year amortization for pollution abatement control and control facilities provide environmental benefits to the entire population, particularly in impacted areas. Tax expenditures for pollution control and abatement rose from $69 million in 1974 to $1,057 million in 1985. In 1989, they rose to $1,918 million, doubling that for traditional resources.[41/]

State and Local Government Expenditures. State and local government spending for natural resources including parks and recreation more than tripled during the 1940-89 period (table 12). It rose from $5.6 billion (constant 1982 dollars) in 1950 to $16.7 billion in 1986.

Table 12. State and Local Government Expenditures for Natural Resources and Parks and Recreation, 1950-1986

Function	1950	1960	1970	1980	1986
	1982 dollars in billions				
Natural Resources	3.9	4.7	7.0	6.5	7.9
Parks and Recreation	1.7	3.1	4.8	7.6	8.8
Total	5.6	7.8	11.8	14.1	16.7

Source: Statistical Abstract of the United States, 1975, Table No. 424, Summary of State and Local Government Finances 1950 to 1973 and Statistical Abstract of the U.S., 1989, Table No. 453, State and Local Governments - Summary of Finances 1980 to 1986.

Thus, it is clear that State and local government spending contributed increasingly to the successful performance of the traditional natural resources. In 1970 and thereafter, total State and local government direct expenditures for traditional natural resources, parks, and recreation exceeded Federal spending (table 2) regularly and increasingly. Thus, the State and local government role outgrew the Federal role in terms of total direct spending for the traditional natural resources.

[40/] Office of Management and Budget, Executive Office of the President, "Tax Expenditures," Special Analyses, Budget of the U.S. Government, Annual Issues for 1976 through 1990.

[41/] Ibid.

State and local government spending for traditional natural resources, excluding parks and recreation, doubled between 1950 and 1986 but remained less than the Federal gross spending exclusive of that for recreation. On the other hand, State and local government spending for parks and recreation grew more than fivefold in this period compared to a fourfold growth in Federal recreation spending between 1950 and 1985. More significantly, however, total park and recreation spending at the State and local levels exceeded Federal spending by a factor of 5.3 throughout this period. That is closely consistent with the estimated relative shares of outdoor recreation provided by Federal lands versus State and local government lands in recent years. Federal land provides about 12 percent of the nation's outdoor recreation activity while State and local lands provide about 74 percent. Those shares produce a State and local lands to Federal lands outdoor recreation activity ratio of 6.2. 42/

Private Sector Spending. Data is not available on private sector spending for the traditional natural resources. Private tree planting may be a useful indicator of trend in private spending but the rate of increase is probably substantially greater than the rate of change in total private spending for natural resources. Private tree planting more than quadrupled between 1950 and 1980, from 413,000 acres to 1,768,000 acres a year (figure 6). In 1988, it rose to 3 million acres. Most of the increase to 1980 was the result of forest industry planting on its own lands. After 1980, the largest part of the increase was on nonindustrial private lands. Federal spending contributing to this acceleration of planting on nonindustrial lands included the USDA cost-sharing incentives under the traditional Agricultural Conservation Program, the Soil Bank program implemented in 1956 and the forestry incentive program initiated in 1974, Federal tax credits for reforestation investments authorized in 1980, and the cost sharing for tree planting on the Conservation Reserve authorized in the 1985 Food Security Act. State cost-share programs and some forest industry cost-share incentives introduced in the 1970's and early 1980's likewise contributed to this upward trend in private tree planting. Tree planting on public lands, by contrast, has remained stable, averaging 390,000 acres a year with relatively small variation since 1960 (figure 6). This stable planting reflects the relative stabilization of timber harvests on Federal and other public lands after 1960.

The tax expenditures for natural resources may be taken as an index of the direction and rate of change in private spending for natural resources. The rate of increase is a factor of 3.8 between 1974 and 1985 and 2.2 between 1974 and 1988. Neither index is a reliable measure of the level of spending in the private sector. However, there can be little doubt that total private spending rose continually in the 1940-1989 period while Federal spending remained relatively stable.

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[42] Cordell, H. Ken, John C. Bergstrom, Lawrence A. Hartman and Donald K. English, 1990, An Analysis of Outdoor Recreation and Wilderness Situation in the United States: 1989-2040, General Technical Report RM 189, Rocky Mountain Forest and Range Expt. Sta., Fort Collins, CO, p. 31

Conclusion

The Federal natural resource policy, leadership, and assistance role combined with more or less stable spending for the traditional natural resources and the recent major increment for the environment appear to have performed reasonably well during the 50 years from 1940 through 1989. The Federal Government role contributed measurably and substantially to maintaining or restoring and improving the nation's resources and environment during this long period of growing and changing resource demands by the expanding U.S. population and economy. The expansion of State and local government and private sector roles in resource spending and management appears to have contributed increasingly over the years to the successful performance of the resources and the improving performance of the environment. Federal, State, and local regulation—and perhaps the threat of such regulation—has also played an important role in expanding State and local government and private sector roles. Underlying this sustained effort to manage and enhance the nation's national resources and environment has been the inherent resilience of the natural resources and their responsiveness to management.

On the resource management side, the rapid growth in knowledge, science, and professional capability as well as technology after 1940 and the management and productivity improvements that they have generated are significant contributions to the performance of the natural resources and environment. Beyond that is the capital nature of the huge resource base, its renewability and its natural ability to sustain a continuous stream of annual outputs and benefits so long as the resource base is maintained or enhanced.

There remain opportunities on every front to further improve the performance of the natural resources and the environment they provide. This is much the way it was at the end of the 19th century when many viewed resource conditions as disastrous or, at best, threatened. It was not greatly different in 1940 nor is it now, except for the difference in the nature and some of the dimensions of the resource and environmental opportunities and challenges confronting America today.

Thus, as it always has been in the past, there remains more to do. But, the United States is better prepared to deal with the problems of today because of the wealth of past experience. In addition, the nation's greatly expanded and growing efforts in resource inventorying, monitoring, and assessment and continuing commitment to natural resource research contribute even more to that capability to deal with current as well as future problems.

The accuracy and completeness of the resource and environmental data being collected by the Federal Government are continually being raised to a level that is more useful as well as more accessible to the States, local governments and policymakers. The States and private sector are increasingly supplementing these Federal data for their own purposes. The improvement in resource and environmental information and assessments, combined with expanding resource management capabilities at the State and local level, provides growing assurance that the dimensions of resource problems will be identified when they are still small, localized, and contained within State borders. Such identification, particularly by State interests at State levels, also helps to ensure that small problems do not become major national problems. This growing systematic and quantitative vigilance for our natural resources and environment, together with the increasing interest and informed concern of our democratic society for their successful performance, may be our strongest insurance policy for assuring that our natural resources and environment will continue to serve our nation well.

APPENDIX A: Recent Publications on Natural Resources Trends

- "An American Crusade for Wildlife" by J.B. Trefethen, published in 1975 by Winchester Press and the Boone and Crochett Club, New York, NY.

- "The Evolving Use and Management of Our Forests, Grasslands and Croplands," Chapter II in Environmental Quality, the 16th Annual Report of the Council of Environmental Quality, Washington, DC, published in 1985.

- "State of the Environment: A View Toward the Nineties," Conservation Foundation, Washington, DC, published in 1987.

- "The Evolving Use and Management of the Nation's Forests, Grasslands, Croplands and Related Resources", published by the U.S. Department of Agriculture, Forest Service as an Appendix Chapter to the 1989 RPA Assessment of the Forest and Rangeland Situation in the United States, Washington, DC.

- "Environmental Trends", cosponsored by the Interagency Advisory Committee on Environmental Trends with the Council on Environmental Quality, Executive Office of the President, Washington, DC, and published in 1989.

- "Natural Resources for the 21st Century," edited by Neil R. Sampson and Dwight Hair of the American Forest Association and published in 1990 by the Island Press, Washington, DC, based on papers presented at the American Forestry Association 1988 Conference on Natural Resources for the 21st Century.

- "Environmental Quality 1987-1988," the 19th Annual Report of the Council on Environmental Quality, Executive Office of the President, Washington, DC, published in 1990.

- "America's Renewable Resources: Historical Trends and Current Challenges" edited by Kenneth D. Frederick and Roger A. Sedjo, Resources for the Future, Washington, DC, 1991.

- "American Forest: A History of Resiliency and Recovery", by Douglas A. MacClerry, U.S. Department of Agriculture, Forest Service, Washington, DC, 1992.

APPENDIX B: Federal Spending Data, Sources and Methodology

Federal net spending information presented in this paper reflects budget outlays for major functional program groups less offsetting receipts allocable to those functional activities. Undistributed offsetting receipts which varied from 1.5 percent to 5.0 percent and averaged about 3.5 percent of net spending for the years represented in figures 2 and 3 were not subtracted. There is no reliable way to distribute these receipts among the functional program groups. Both on-budget and off-budget spending are included.

Net Federal spending, except for the undistributed receipts, represents the direct burden of Federal programs on taxpayers. Data for net spending are taken from the Historical Tables, Budget of the United States Government, Fiscal Year 1990, Table 3.1, Outlays by Superfunction and Function, 1940- 1994. Data are taken for 5-year intervals beginning with 1940, except for FY 1989. The nominal spending data from table 3.1 is reduced to constant 1982 dollars using deflators implicit in table 6.1, Composition of Outlays in Current and in Constant FY 1982 Dollars, 1940-1994. Table 6.1 information provides different implicit deflators for defense, net interest, payments to individuals (mainly entitlements), grants to States and local governments exclusive of payments to individuals and for all other functions as an aggregate. The last two functions were combined to determine a single implicit deflator since this analysis of Federal net spending does not separate grants to States and local government. This deflator was applied to all functions except defense, entitlements, and net interest, which had separate deflators.

Federal Gross Spending for Natural Resources Data, Sources and Methodology

Federal gross spending data were obtained for individual years directly from the Budget of the United States Government tables showing Federal programs by agency and account numbers. Outlay or expenditure data were taken only for the "actual years" except for 1989, for which only estimates were available in the 1990 Budget. The account numbers by natural resource subfunctions are as follows:

Natural Resource Subfunctions	Account Number
Water Resources	301
Conservation and Land Management	302
Recreation Resources	303
Pollution Control and Abatement	304
Other Natural Resources	306

Agency program outlay data consistent with these account numbers were available back to FY 1961. For the years 1940-1960 it was necessary to track outlay or expenditure data by agency and program consistent with the account codes and allocations for the years after 1960.

Outlay data included both appropriated funds and trust funds. No receipts data were subtracted from outlay totals. Public enterprise funds and working capital funds were excluded. No effort was made to determine natural resource spending for agencies or programs not identified with the natural resources budget account codes for the 1961-1989 period. Agencies and programs excluded are the Tennessee Valley Authority, the Department of Energy, the military functions of the Department of Defense, the National Aeronautics and Space Administration, the Department of Labor, the Department of Health and Human Services, the National Science Foundation, and others. Also excluded are natural resource outlays in Federal agency programs and account codes that have primary objectives other than natural resources. These include minor components of programs whose primary objectives are agricultural research, transportation development, extension education, regional and community development, and others. The spending data likewise exclude the value of financial and in-kind donations and volunteer services for Federal programs and lands. These have increased in recent years and contribute to the benefits of Federal programs and lands.

Nominal spending data for the several natural resources subfunctions are adjusted for inflation to constant 1982 dollars using the same deflators applied to the net spending data for natural resources.

Spending averages and percentages are calculated and graphs drawn using the 5-year spending data as representative estimates of the annual spending data. A careful visual inspection was made of the available annual data to ensure that this method of plotting and graphing did not involve any major distortions in the trends and relationships among the resource subfunctions.